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F. A. WIRT, President — RAYMOND OLNEY, Secretary-Treasurer

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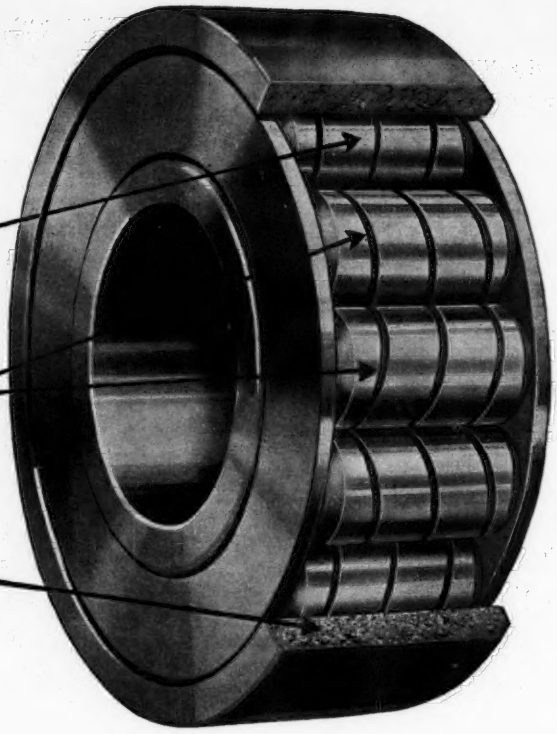

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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, Editor

Vol. 7 FEBRUARY, 1926 No. 2

EDITORIALS

Engineering in the Farm Home

THE application of engineering to the farm home stands out among the phases of work that are claiming the attention of agricultural engineers as an opportunity for definite service.

Efforts of agricultural engineers have been effective in aiding in the development of farm power and machinery, in the study of the application of electricity to agricultural operations, in the reclamation of land for profitable farming, and in the reduction of the cost of producing farm crops and livestock.

Of equal importance to man's effort to develop farming is the woman's problem of maintaining a home that is more than a mere shelter. In her efforts she works twelve hours each day in actual duties. A large portion of this time is spent carrying water, cleaning lamps, doing the washing by hand, carry out wastes, and walking an untold distance in the performance of her duties. Less than ten per cent of our farm homes are equipped with modern conveniences.

The field for service is practically untouched. It is the duty and privilege of the agricultural engineer to apply his ability in an effort to find out the needs of the farm home, plan attractive and convenient houses, develop the equipment necessary to replace hand labor with mechanical devices, and finally to give his support to all agencies that are working toward the betterment of the home on the farm.

DEANE G. CARTER

A Significant Sign

WHEN there is unity of purpose and effort behind a good cause the success of that cause is assured. A conference of the heads of agricultural-engineering departments or those in charge of agricultural-engineering work at the land-grant institutions of the country was held at Madison, Wisconsin, in June, in connection with the annual meeting of the American Society of Agricultural Engineers. Twenty-six states were represented at this meeting. Perhaps the most significant thing about it, so far as the future of the agricultural-engineering profession is concerned, was the good fellowship, the harmony of ideas, the fine spirit of cooperation, and the intense enthusiasm which was so apparent during the entire conference. Matters of outstanding importance to the department heads and the whole conference was noticeably devoid of controversial features.

It should be said also that the same thing may be said of the entire annual meeting of the Society. Anyone attending the various sessions of the convention could not help but be impressed with the fact that not only are agricultural engineers fully alive to the problems confronting them, for the most part, but that the rank and file of the profession are big enough and broad enough to work together in a spirit of friendly cooperation as the most effective way of accomplishing the things of greatest benefit to the profession. It should also be said that this attitude is becoming more noticeable each year at our annual meetings. It is indeed a most significant sign for it is undoubtedly the most important factor essential to insuring the rapid, well-balanced development of the profession.

It is indeed a happy situation when professional men are willing to put their own opinions and ideas to the test among fellow members of their profession and cheerfully abide by the judgment of the majority, especially when it involves matters pertaining to the advancement and general good of the profession. It is devoutly to be wished that the spirit which prevailed at Madison last June will continue to be the dominating spirit at all meetings of the Society and in all the activities of agricultural engineers. Rotary International has as its slogan, "Service above self. He profits most who serves best." That philosophy is the ruling spirit in the agricultural-engineering profession today. It is to the personal interest and advantage of every agricultural engineer to see that it continues.

An Old Profession—A New Society

THE importance of agricultural engineering is known the world over and it remains for us as agricultural engineers to connect that popular recognition with the term itself and with the national society which represents it. Every day the popular orator begins his speech about like this: "Two thousand years ago the farmer plowed his ground with a wooden plow, harrowed it with a wooden harrow, sowed the seed by hand and harvested the grain with a sickle. Seventy-five years ago my grandfather did the same work with wooden tools except that the harvesting was improved slightly by the use of the cradle. Today—."

The rest of the story is familiar. Inventions and improved methods have transformed agriculture. It becomes the pleasure of the agricultural engineer to inform the speaker that he is talking about "agricultural engineering." The speaker smiles, and perhaps next time he will add even more enthusiasm to his story. He has connected the history of the progress of the world's oldest and greatest industry with a term and a society which are rapidly growing in strength and recognition.

D. B. LUCAS

Farm Mechanics

FARM mechanics is that branch of study and practice that deals with the application of mechanical principles to machines, buildings and devices used in agriculture. The purpose of farm mechanics instruction should be (1) to teach the fundamental principles necessary for the successful adjustment, operation, care or repair of farm machines, buildings and other devices, and (2) to give sufficient practice in the various mechanical operations so that one can keep farm equipment functioning properly and can also build equipment of the simpler kinds.

Farm mechanics is a means of training young men, or others who are not familiar with technical engineering, in the practical every-day application of engineering to agriculture. It differs, on the one hand, from farm shop work in which the practice is likely to be emphasized and the underlying principles neglected, and, on the other hand, from engineering in which principles are apt to be over emphasized.

The acts of Congress that made possible the teaching of vocational agriculture in schools of secondary grade have given us unlimited opportunities to teach some of the principles of mathematics, physics and chemistry (engineering, if you please), that applies to farm equipment, to persons who will actually till the soil. It appears that this is a splendid field that we cannot afford to neglect.

JAMES KOEBER

Agricultural Engineering in England

THE January 1926 issue of "The Implement and Machinery Review," of London, contains an item of interest to agricultural engineers on the activities of the Institute of Agricultural Engineering at the University of Oxford. It will be remembered that Capt. B. J. Owen (Mem. A.S.A.E.) is the director of the Institute. The advisory work that this institution is called upon to do in behalf of farmers and the government has attained such enormous proportions that the institute staff as at present accommodated and constituted cannot fully cope with it, and a movement to larger buildings and the employment of extra assistance is said to be inevitable. Farmers themselves are making great use of the advisory service provided, in many instances seeking advice on what class of implement or machine to buy for work of a given nature, information that is supplied most readily; indeed, it is said that the activities of the institute in this direction alone have been so great as to swamp other departments, such as research, testing and experiment, education, etc., for the time being.

A most interesting side of the work, however, must not be overlooked, and that is the one in which university graduates, those who have taken the degree of bachelor of agriculture, receive a preliminary preparation at the institute, and then the director of the latter arranges for them to receive a course in practical training in a large implement works.

Paine Assistant Director of C.R.E.A.

ANNOUNCEMENT is made by Dr. E. A. White, director of the Committee on the Relation of Electricity to Agriculture, that Frank D. Paine, professor of agricultural engineering, Iowa State College, has been appointed assistant director of the committee and has been tendered a leave of absence from Iowa State College for one year.

Prof. Paine has held the position of professor of agricultural engineering at Iowa State College since 1912. He has taken an active part in the work of the Iowa section of the National Electric Light Association, serving as associate member on the Rural Lines Committee and the Committee on Meters. He was the originator of the idea of a short-course for electric meter men, and directed the first one at Ames in 1919. He has practiced as one of the consulting engineers in Iowa working with many of the public utility companies of the State. Since September 1924 he has served as supervisor of the Iowa project on rural electrification and has been given credit for the success of the organization and the progress of this work in Iowa.

LETTERS

The Editor welcomes letters from A.S.A.E. members and other readers discussing the contents of AGRICULTURAL ENGINEERING or any question related to the agricultural-engineering field, but he reserves the right to judge as to the suitability of such letters for publication. Neither he nor the Society will undertake to be held accountable for the facts and opinions presented. The Editor also welcomes for publication such correspondence between A.S.A.E. members relative to Society activities and the general development of the agricultural-engineering profession as would be of general interest to the field.

SLUICING METHOD OF DITCHING NOT NEW

Editor, AGRICULTURAL ENGINEERING:

SEVERAL articles have appeared of late on ditching for irrigation drainage by sluicing. References are made to this method as though the idea was new. While the method may be new in the irrigation field, it is old in the drainage of wet lands. English books describe methods of cleaning and deepening ditches by loosening the bottom with especially prepared cultural tools in order that high water can flood out the loosened material. Forty to fifty years ago cylinders taken from old threshing machines were used in the central states to construct ditches in the same way as described by use of the Purvis on page 306 of the December issue of AGRICULTURAL ENGINEERING. In 1906 the writer observed the operation of a threshing machine cylinder on a ditch in the Red River Valley, Minnesota, and still has the plan of the device designed by the operator of this cylinder that was more effective in making a large ditch. As a general statement such devices have not been found satisfactory for drainage work in the humid states.

JOHN T. STEWART

Consulting Engineer
St. Paul, Minnesota

IT'S THE EXTENSION MAN'S MOVE

Mr. Raymond Olney, Secretary
American Society of Agricultural Engineers
St. Joseph, Michigan
Dear Mr. Olney:

I AM wondering if the American Society of Agricultural Engineers has ever expressed itself on the place that agricultural engineering extension should have in the Society. In reading reports of other organizations similar to ours, I find that they have expressed themselves on extension work, but I have been unable to find anything regarding this work in our Society. The extension work means a great deal to each member because it is through this source that agricultural engineering knowledge is disseminated to the farming people. I am bringing this subject up at this time in the hope that it will receive some attention at the next annual meeting.

Another point regarding extension work is the meetings of the extension men at the annual meeting. During the last two years we have had a meeting, but the entire meeting at both sessions was utilized by a few, and I do not believe interested the majority of extension men.

Rather than discuss one particular phase of extension work, it seems to me the meeting of extension men should have a regular object, this object being the discussion of ways and means of bettering extension work in agricultural engineering to the advantage of all concerned. My suggestion for the meeting would be to discuss methods of carrying on field demonstrations, the different procedures, the collection of data, subject matter and office records; also to discuss, if possible, the relationship that should exist between the extension men, the experiment station, and the resident teaching staff. I believe some very interesting, instructive and constructive discussions would result from a meeting of this sort.

This is merely a suggestion and if it is acted upon I believe the extension work being carried on by the men will be better, and in the end will bring much credit to the Society as a whole.

I would be glad to have your frank opinion on this, and if the suggestion is worth while I would be glad to know what will be done with it.

A. J. McADAMS

Land Reclamation Specialist
Missouri College of Agriculture

* * *

The Secretary replied to the foreging letter as follows:

Dear Mr. McAdams:

I am pleased to have your letter of December 1, relative to the place of agricultural engineering extension in the activities of the Society; I feel your letter should be given circulation among our members through AGRICULTURAL ENGINEERING. I sincerely hope its publication will have the effect of interesting other extension men in a program such as you outline.

I am confident the Meetings Committee will be glad to help make is possible for the extension men to have adequate time not only to discuss their problems at the next annual meeting, but also to discuss a program of extension activities and organization that will put agricultural engineering extension where it belongs in Society activities.

I feel that we cannot too strongly emphasize the importance of this matter, and you are to be commended for agitating it. I am sure that, if you extension men come forward with a plan and a program you will receive every consideration. I would go so far as to say that the way to accomplish what you have in mind is already open; it seems to me that really the next move is up to the extension men themselves.

RAYMOND OLNEY

Secretary, A.S.A.E.

The Field of the American Society of Agricultural Engineers in Reclamation*

By O. V. P. Stout

Mem. A.S.A.E. Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture. Chairman, Reclamation Division, American Society of Agricultural Engineers

WHEN men were first called engineers the military service and public work occupied nearly all of them, so that the two designations, military engineer and civil engineer, sufficed for the time. With the development of the steam engine it came to pass that a distinction was made between the engineering of fixed works and that of motive power and machinery, and we had the mechanical engineer. Then a group of engineers became identified so distinctly and so exclusively with the mining industry that they became known as mining engineers.

As each group thereafter emerged and progressed to the point where it functioned in a fairly definite field its leaders sensed the need and value of association and coherence, and brought about the organization of a national society with membership drawn from the group.

The process outlined above took place first in Great Britain, followed by America. It has continued in more or less similar form until now the number and variety of national engineering societies in America alone is such that a classification embracing all of them would carry us into consideration of combinations, offshoots, adjuncts and what not, and too far from the main subject of this discussion. Our present purpose will be served if account is taken, on the one hand, of a class composed of the chief among those branches of engineering, each with its national society, which have as their respective distinguishing characteristics the application of some particular principle or force of nature, somewhat independently of the subject to which it is applied and the resulting product; and on the other hand, of a second class, composed of those branches of engineering whose segregation is based on the nature of the field within which the various principles and forces of nature are applied. Taken in this way, the first class includes civil, mechanical and electrical engineering. Civil and mechanical engineering divide between them the field of the application of mechanical forces, the statical application being characteristic of the former and the dynamical of the latter. The electrical engineers characteristically concern themselves with the generation, transmission and delivery of electric energy. As examples of the second class, mining and agricultural engineering will be cited, as engaged in the application of the various principles and forces of nature to the respective industries of mineral and agricultural production. The first class will be referred to as the fundamental branches of engineering and the second at the industrial branches. These considerations lead to a concept of cross classification, which can be presented in the following form:

Industrial Branches	Fundamental Branches		
	Civil	Mechanical	Electrical
Mining	X	X	X
Agricultural	X	X	X

It is submitted that while civil, mechanical and electrical engineering are all in large degree mutually exclusive, any one of them may find in either the mining or agricultural industry employment that is wholly within his proper sphere; and that the mining or agricultural engineer, of necessity and each within the limits of his corresponding industry, encounters tasks and problems which fall within the provinces of civil, mechanical and electrical engineering.

National Engineering Society. In view of the expenditure of time and money demanded by national engineering societies of their members, they must be able to accomplish something that will justify the outlay. Each society has formulated a statement of its purpose and function. From these statements and from the record of activities as it appears in the transactions and proceedings of the societies it seems that the most important function, one to which all others are contributory, is participation as an active or leading and directing agency in building up and making available an organized body of knowledge relating to the field of the profession. It is to this end that the work of the societies tends continually to become more and more systematic, as witnessed by the careful and thorough reports of working committees, the organization into divisions, and other features which have accrued.

In the exercise of this function it should be the aim to avoid unnecessary duplication of work as between the different societies. This injunction lies with especial force against the societies of the industrial branches of engineering. These should not undertake extended work along lines which are rather completely covered by the societies of the fundamental branches. Their policy should be to encourage a contact with the work of the fundamental branches so far as it applies to their field, and confine or limit their own activities to the extension of such work into the phases particularly attaching to their respective industries.

The Agricultural Engineer. I have heard engineers declaim (not recently however) that there is no such thing as an agricultural engineer or agricultural engineering. If this idea should persist, it seems to me that it it fully met by the proposition of cross classification, which puts the justification for agricultural engineering on the same plane as that of the old established profession of mining engineering. Agricultural engineering is the engineering of the industry of agricultural production and concerns itself with the tasks and problems peculiar to that industry. Although the segregation and the widespread recognition of the agricultural engineer is a comparatively recent development, it was foreshadowed long ago, and evidence can be adduced that he is not an upstart but a logical outcome of earlier as well as later views and conditions. In 1847, on the occasion of the decease of a Mr. Handley, an associate of the Institution of Civil Engineers of Great Britain, the following remarks were made before a meeting of that society: "Mr. Handley was an eminent agriculturalist, and laboured with energy, both in his public positions as a member of Parliament and as a leading member of the Royal Agricultural Society, to introduce measures for the combination of Engineering and Agriculture." Alexander Lyman Holley, one of the greatest of nineteenth century American engineers, vice-president of the American Society of Civil Engineers and of the American Society of Mechanical Engineers, and president of the American Institute of Mining Engineers, in an address at the organization of the American Society of Mechanical Engineers nearly 46 years ago, said, "Modern agriculture is but a world-wide arena for the operation of machines. These, and the machines that produce them draw upon many departments of mechanical engineering."

Reclamation. For the opening of this discussion the term "reclamation" will be taken to include the operations and in each case to cover the process of bringing to a high grade of usefulness in crop production land which at the inception of the undertaking are either in an unproductive state or are of inferior or limited capacity to produce.

*Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, at University Farm, Davis, Calif., December 18, 1925.

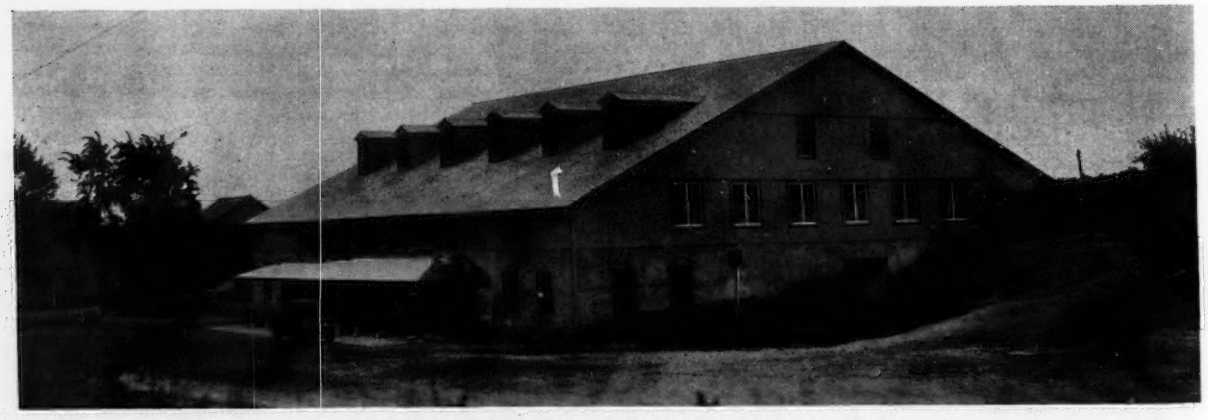
This definition, if acceptable now, would have been equally so if proposed twenty-five years ago. The range covered by the definition would not, however, have been realized in the earlier period. The operations now acknowledged to be embraced in reclamation are many more than were generally assigned to it at that time, and we have come to know that the process of reclamation does not terminate nor become assured of completion where and whom we assumed that it did. We have had forced upon us the fact that it is not complete until the land has been subdued, in all that the term subdue implies, and brought to an advanced and complete state of cultivation and production; and not until there is on the land a full complement of adequate farm homes and well-planned farmsteads, with the ownership on a secure financial and economic basis.

There are a multitude of different states or conditions in which land may be found or into which it may fall which offer a field for reclamation. It may be either permanently or at intervals or seasons too wet or too dry. It may be too strongly impregnated with minerals salts, or it may carry the refuse of industrial operations. It may lack elements of fertility which it is practicable to introduce and maintain. It may be covered with growths which impede or inhibit cultivation. Any one of us could probably extend the list. The remedy in some cases calls for community or corporate action. In others there is opportunity for complete independent procedure within the scope of operations of the individual land owner. In nearly all instances under all of them in this country up to this time the ultimate steps to reclamation have depended on the owner or occupant of the land, acting in his individual capacity.

The Field of the American Society of Agricultural Engineers in Reclamation. Agricultural engineering has been classified in this discussion as the industrial branch of engineering which concerns itself with agricultural production. The economic purpose of reclamation is agricultural production. Therefore, we incline to assume at once that there is a field for the agricultural engineer and the American Society of Agricultural Engineers in reclamation. However, if we attempt to envisage their field as coextensive with the engineering of reclamation we find some material overlaps, with some of the fundamental branches of engineering in position to assert claims of priority of occupation. The science and the art of the design, location and construction of works to water arid tracts of land have been developed almost entirely within civil engineering lines. Much of the progress in America has been accomplished within a comparatively recent period, so that whereas no longer than thirty years ago we had to turn to foreign countries for models of excellence and precedents of magnitude in irrigation engineering, we now find America able to show examples which are second to none. The record of these achievements and of the scientific considerations on which they are based and which have been developed in connection with them have been given attention in the papers and discussions at the meetings of the American Society of Civil Engineers and place in the publications. This it seems that the case of priority of occupation of the field of irrigation works of magnitude is clearly established. If priority were all, however, and it could be shown that the agricultural engineers in sufficient number and with a training superior for the purpose would soon be available to render an even higher grade of service than that which has been noted, then the principle that "the first in time is the first in right" might not apply with sufficient force to prevent the agricultural engineers from moving to take over the field. There is nothing in the situation to give support to the idea of such a development, and I have to learn that it has been entertained. In the colleges the students in the professional agricultural engineering groups are given instruction in irrigation engineering, and there is no reason why, with later experience of the right kind, some of them may not become engineers of large irrigation works. But this is merely an aspect of the case as it applies to individuals. The group trained primarily as agricultural engineers is not that from which the supply of engineers for these larger works will be drawn, nor is the American Society of Agricultural Engineers the organization which in the nature of things is the logical one to assume the lead in the future progress in the growth of the organized body of knowledge relating to the engineering of large works for reclamation by irrigation. Such being the case, it seems appropriate and desirable that any contributions which members of this Society may be able to make to this particular body of knowledge should be made through other channels, and that this Society should not invite nor encourage such contributions to its proceedings.

The situation in respect of other large works of reclamation, including drainage and flood control, is manifestly similar to that which obtains in connection with irrigation. That is to say the province of the American Society of Agricultural Engineers does not extend to include the design and construction of the largest ways and structures. There is this, however, to be said, just as in irrigation, that in the decision as to capacity requirements of these larger works the qualified agricultural engineer will prove a most valuable consultant and in many cases the decision should rest with him. It follows therefore that the capacity requirements of reclamation works of whatever size or character is a subject within the field of this Society.

What then, some may inquire, is left for agricultural engineering in reclamation? And is agricultural engineering to be awarded only the leavings and the smaller items of reclamation engineering? In a way this is the fact. But a little consideration will show that this fact gives neither the agricultural engineering profession nor the American Society of Agricultural Engineers the least occasion for despair nor to be ashamed. The main canals and distributaries, dams and



STORAGE CELLAR AND ROADSIDE MARKET COMBINED

This picture illustrates a good example of a modern fruit and vegetable storage. It is owned by General Harry C. Beckler, Allentown, Pennsylvania. This structure combines a storage cellar, packing room above, and utilizes the roadside market idea. The cellar is of concrete and has a capacity of 40,000 bushels. The packing room contains graders and sorting tables

diversion works, tunnels, flumes, U-tubes, wasteways, checks, regulators and all principal ways and structures will be of no avail in the accomplishment of the reclamation of the region or tract for which they have been constructed until the supplementary ways and structures have been provided, the unfavorable topographic features of the land surface to be irrigated have been altered to conform to the requirements for best results in the application of the water, and from amongst the multiplicity of existing and conceivable farm systems of irrigation one or another has been selected and installed on each farm or group of farms. All of these, together with the location and construction of community roads, farm water supply and farm sanitation, the layout of fields, farmsteads and centers, and the design of farm buildings are matters calling for engineering service and direction in order that the best results from the standpoint of efficiency and economy may ensue in a finished project of reclamation by irrigation. Nevertheless, up to this time the mark of the engineer is missing from the most of them. The tenor of present day discussion, however, seems to warrant the expectation that there will be an immediate and continuing improvement in this respect. Such being the case, there opens up for the agricultural engineer and for his national society a field which, at the same time that it is largely made up of items which in comparison with items of the larger works may seem minor or petty, in the aggregate covers a range and forms a magnitude which can be expressed only in terms which are the complete antitheses of "minor" and "petty." Morever, this field, due to neglect in the past to attach full importance to it as a theater of engineering endeavor, presents now and for some time to come more of an opportunity for effective work of an engineering society than does the rounding out of the already advanced practice in large works.

Inasmuch as it has been shown that it is important that the work of the agricultural engineer should attach to the finishing of an irrigation project it follows that he should be on the ground at the inception of the project also, in order that he may assist in arriving at the judgment which should be formed at that time as to the practicability of completing in due season the entire process of reclamation as it has been defined in this discussion. In this it will devolve on him to ascertain and interpret all of the facts and factors of the situation which have or may have a bearing on the feasibility of an economic agricultural utilization of the land. It becomes accordingly the part of the American Society of Agricultural Engineers to take the lead and direction in building up and making available an organized body of knowledge covering the subject of the agricultural feasibility of reclamation enterprises.

The operation and maintenance of an irrigation system presents problems equally as complicated and frequently approximating the same order of magnitude as those which attach to the planning and construction of the system in the first place. To a major extent they are of a nature which may with propriety be considered by the American Society of Agricultural Engineers and without danger of meeting resentment on the score of priority of another society in this detail of the field.

A consideration of the fields of reclamation by drainage and by flood control would develop a demarcation closely analogous to that which has been indicated for irrigation.

Where the primary operations of reclamation consist solely of those directed to the subduing of the land, and where this can be accomplished on adjacent small areas independently of each other, it does not appear that any priority of engineering occupation is encountered by the agricultural engineer or the American Society of Agricultural Engineers. The assignment of the engineering of reclamation of cut-over lands, for instance, is therefore made without reservation to agricultural engineering.

Engineers have had a large part in the valuation of the properties of public utilities and the establishment of rates for service. Some of the most effective studies of these subjects have been made by engineers. Their analyses and conclusions appear in the publications of engineering societies, where it can be shown that many, in fact a considerable majority, of the principles which have become embodied in court decisions and in the rulings of regulatory bodies and which now govern in such matters were first conceived and formulated by engineers. The assignment of the engineer to this work was at first due to his familiarity with its physical basis, but he has carried it forward to less tangible elements on the basis of his training and practice in analysis. There are already strong indications that engineers will play an equally important part in the development and formulation of the financial and economic principles which are to guide in the settlement of lands as a directed step in reclamation. As in the case of utility valuation, the proceedings of his national engineering society is the best place for the record and appraisal of his achievements in this line. The treatment of these financial and economic questions, together with a study and working out of appurtenant sociological problems, constitutes a field which it seems must be looked upon as wide open to any who can contribute anything of benefit, be they engineers of whatever branch or not engineers at all. Although it may be anticipated that the eventual custody of the complete and systematic record of achievement in this line will fall elsewhere than to an engineering society, there appears to be good reason why for the present and for some time to come any of these societies which have a contact with reclamation should take an active interest in settlement on reclaimed lands.

In the foregoing paragraphs the partition of the civil engineering phase of reclamation between civil and agricultural engineering has been foremost in mind, and the mechanical and electrical engineering phases have been passed over. The principal field of the largest pumps is in reclamation. The design of a pump as a whole, of whatever size or capacity, scarcely falls to the agricultural engineer, but the testing and study of these designs is within his province. There are features of design which agricultural engineers, on behalf of the users of pumps, are investigating and seeking to improve. The situation is much the same in regard to the farm tractor. It may be noted that although the tractor is by no means exclusively an instrument of reclamation it has extensive use in that connection and a leading type was first developed in connection with reclamation. The fact that the agricultural engineer is already identified with tractor development in general may have a bearing on this item. The construction and maintenance of small irrigation distributaries and drainage channels, farm ditches for both irrigation and drainage, and devices for the installation and maintenance of various types of farm irrigation and drainage systems call for specially designed machinery. It may well be that the agricultural engineer, as the user of these machines, is well qualified in many instances to originate or improve the design.

From these considerations it appears that the agricultural engineer is involved in the mechanical engineering phase of reclamation in such a way as to obligate this Society to keep open its proceedings to the treatment and discussion of mechanical engineering subjects such as these enumerated.

In connection with the electrical engineering phase of reclamation the agricultural engineer will serve chiefly, although not exclusively, as a consultant to the consumer of electricity, advising him as to types and disposition of machines and distribution of load thereon, to the end of securing the maximum practicable efficiency in performance and the most economic adaptation to rate schedules. This justifies the Society in holding within its scope the comprehensive and detailed consideration of farm plants, and probably all but the largest plants using electric power for reclamation purposes.

In approaching the close of this paper it should be pointed out that a consideration of our topic reveals continually accruing emphasis to the position of the agricultural engineer as the servant and advisor of the individual farmer or settler on lands projected for reclamation. This is manifest to such a degree as to constitute a guiding principle of inclusion in any attempt to define the field of agricultural engineering.

In conclusion it is submitted that the field of the American Society of Agricultural Engineers in reclamation is one which must present itself as satisfactory and inspiring to those of the members whose work lies in that field; and, further, that there is no apparent ground upon which it may be expected

that the national societies of the fundamental branches of engineering will base objection to the occupation by this Society of the field herein indicated.

Discussion by W. R. Parkhill

Member American Society of Civil Engineers
Presented by A. E. Backman
Assoc. Mem. A.S.A.E. Assistant Engineer Appraiser, Federal Land Bank of Berkeley

IT IS hard to conceive of a broader statement of this subject than that presented by Major Stout in the foregoing.

Present day progress is attended by more diversification in every line of human endeavor—engineering is no exception—hence we must not look with disfavor upon specialists, and my conception of the agricultural engineer is the engineer who specializes in agriculture. It is inevitable, with the more complex problems to be solved in undertaking land reclamation, that more factors requiring special agricultural training for their solution must be given careful consideration.

Engineers of the West in planning works—irrigation, power, railroads, highways and bridges—have perhaps given less consideration to the economics of the situation than in the East; naturally, because it has been the usual thing that the demand for and value of the works have generally come ahead of their construction or the construction immediately justified. This condition no longer exists, especially with reference to works for land reclamation.

There is special significance in the statement of Major Stout that land reclamation is not complete until the land has been subdued—brought to a complete state of cultivation and production, and with the ownership on a secure financial and economic basis. This implies at once that in planning any reclamation project, more study and investigation must be given to the possible progress of the land utilization under existing economic conditions than has been done in the past. More thought must be given and economic studies made as to the time and expense involved in getting the lands entirely into production so that these lands can bear the extra burden of maintaining and paying for the constructed works of reclamation. Herein lies the field of the agricultural engineer.

The following is quoted from the report of the Section on Irrigation of the Commonwealth Club of California, dated November 24, 1925, page 398:

> "The future agricultural development in California will be mainly dependent on irrigation and an orderly progress in such development should be encouraged. Such encouragement at present can best be extended in assistance in adjusting complications regarding water rights and in emphasizing that plans for the utilization of the lands are more essential than plans for the construction of the irrigation works."

The civil engineer can be depended upon to design and carry out construction of the works of reclamation, just as he has done so well in the past even down to the smallest structure. As these smaller structures, and even the capacities of larger works, in the case of irrigation must be designed with regard to the requirements of water for the individual farm or group of farms constituting a unit as related to any structures in question, and these units may vary in their requirements with either the soil or the nature of cropping, it is entirely conceivable that the agricultural engineer should be brought into the final determination of structure and capacity requirements. Here his duty should cease, and not partake in the design or construction of such structures. His greatest field in this connection must have to do with determing the most probable demands on the structure to be built from his experience and acquired knowledge of the best utilization of the lands to be reclaimed or similar lands that have been reclaimed.

He must go further than this—in the case of new projects, determine from existing conditions the time element as to need of reclaiming part or all of the lands and their value and earning power when reclaimed, so that the cost of constructed works will fall within the value under the changed conditions to be brought about by the reclamation. If the value of the reclamation cannot be justified by such economic analysis, then the project must be abandoned or delayed. He will have to consider land values existing and their control, size of economic ownership, adaptability of soils and their preparation for best-suited crops, transportation and markets, and be able to show that it will be possible for the landowners to adapt their crops and cropping methods to the changed conditions in the time required to produce revenues for sustaining the reclamation works and pay off the costs.

I know of many instances where the failure or near failure of projects or depreciated land values have resulted from lack of consideration of these problems or the taking of steps to solve them only after the project was constructed.

New reclamation projects, constructed and with these economic difficulties facing them, could well afford to employ someone capable of studying these factors, analyzing the conditions that will better them and giving publicity to these findings, and even acting in an advisory way without cost to the owners of lands being developed or to others needing to increase their returns by adopting better methods or changing their cropping procedure. Here again is the field of the agricultural engineer.

This discussion can perhaps be made of greater value by giving the results of my observations having a bearing upon the factors which have caused failures or near failures of projects, or have resulted in depreciation of land values in such projects, than by generalizing. In the time allowed for preparation of this discussion it has not been possible even to include all the projects which the data available would permit of using with some more detail analysis for which time could not be taken. Forty-five projects have been selected over a wide range, and it is believed the results of the analysis of troubls which follows would not be materially changed if a majority of such projects (which might cover one hundred or more) were included. These 45 projects include 4 government irrigation projects, 29 irrigation districts, 2 state-fostered projects, and 10 private irrigation companies—all located in Oregon, California, Utah, Nevada and Arizona. The whole field has not been covered by any means—only such projects as I have personal knowledge of and concerning which I believe I have sufficient information to say what trouble or lack of consideration has resulted in the failure, near failure or depreciated land values.

It was desired to determine what proportion of the troubles resulted from purely engineering faults, and what from lack of economic considerations. As might be expected, when taking up each in some detail responsibility had to be divided in many cases. A few projects fall entirely within each major group. As to the entire 45 projects, 28 per cent of the defects may be classed as engineering faults and 72 per cent to lack of economic considerations or of the curing of economic shortcomings, if such are possible of curing.

Reasons for Failure, Near Failure or Depreciated Land Values in Forty-Five Selected Projects and Relative Importance of These Faults

(a)	Engineering Faults	28%
	1. Insufficient water supply	12.3%
	2. Lack of drainage facilities	6.7
	3. Underestimate of cost of construction	5.6
	4. Excessive cost of operation and maintenance	3.4
(b)	Lack of Economic Considerations	72%
	1. Settlement difficulties (poor demand for land or slowness of complete utilization)	21.1%
	2. Poor or unadaptable soils	15.6
	3. Cost burden too great for earning values	14.4
	4. Overestimate of value of adaptable crops	8.8
	5. Slowness of adaptation to changed economic conditions	4.4
	6. Ownership difficulties (size of holdings and control of values)	4.4
	7. Insufficient transportation and markets	3.3

The writer does not wish to convey the idea that forty-five sizable western projects are failures or near failures or the lands in some of small value, hence some further explanation is in order. Some of these projects have been failures but later have developed into going concerns when the evils have been corrected; others are still struggling along with hopeful chances of recovery. Probably the largest group is that of projects in which there are depreciated land values—meaning by this where the land values are below what they should be and probably will be with one or more of the economic faults

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Depreciation of Farm Machinery*

By Lew Wallace

Jun. Mem. A.S.A.E. Agricultural Engineering Department, Iowa State College

THE manufacturing industries are always concerned with the cost of production. Therefore, they are utilizing every effort to reduce such cost to a minimum. One of the factors which enters into the cost of production is the depreciation of physical equipment. In some lines of industry this is of greater importance than in others. Depreciation of physical equipment is an item that cannot be ignored, but must be provided for in some way or another. However, it is not subject to such rapid fluctuations as are some of the other items that make up the cost of production.

Depreciation is a term used to denote that financial method used to recoup financial losses due to the replacement of items of physical equipment at the end of their service life. There are several methods used to provide for depreciation. In a general way each method provides that a certain sum be set aside at regular or irregular intervals which will, at the end of the service life of the item of physical equipment, equal the value of the item when new. Depreciation is used in utility valuation and accounting with two meanings: the actual loss in value and the financial method (or method of accounting) used to recoup in value from depreciation. There is no general agreement between engineers as to what the loss of value from depreciation should be. There are several methods used to recoup losses from depreciation. The more important are known by the following names: straight line, compound interest, sinking fund, and retirancy reserve methods.

The straight line method is used most extensively. However, the compound interest method gives results correspondingly closer to the true losses of value than any other method yet developed and is most favored by engineering experts. Of the methods mentioned, the last three provide that the amounts set aside on account of depreciation must accumulate until the end of the service life of the items of physical equipment. Anson Marston, dean of engineering at Iowa State College, who has devoted much time and intensive study to the subject of depreciation in connection with the evaluation of public utilities, advocates that the value of an item of utility physical property at any age equal the present worth of all future services.

Before any of the above-mentioned methods can be applied in determining the depreciation of farm machinery with any degree of accuracy, a considerable amount of data must be collected from the farmer or user of agricultural implements.

*Paper presented at the 19th annual meeting of the American Society of Agricultural Engineers, at Madison, Wis., June, 1925.

Kind of Machine_____ Model_____ Serial No._____ Size_____

Manufacturer_____ Address_____

Cost New_____ Cost 2nd Hand_____ Age 2nd Hand_____ Condition 2nd Hand_____

Size of Farm_____ Topography _____ Farm Shop_____ Size of Shop_____

Shop Equipment_____ General Appearance of Farm Equipment_____

Owner_____ Address_____ County_____

SERVICE RECORD BY AGE INTERVALS

Age Interval	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23
Year																							
Days Used																							
Acres Covered																							
Repairs																							
Housing																							
Painting																							

Total Years Used_____

1. Sold. 2. Too Small.
2. Worn Out. 4. Obselete
5. Broken Beyond Repair
6. Operation too Expensive
7. Manufacture Discontinued
8. _____

GENERAL REMARKS_____

DATE _____ 1924 BY_____

Data sheet used in survey to determine the depreciation of farm machinery

It is pretty generally recognized that the farmer is a rather poor business man. That, in most cases, no records of farm machinery are kept, which probably accounts for the fact we do not have the necessary data at hand at the present time. It is necessary to know the average life of the various farm implements before any depreciation method can be used. Since there are a great many factors which may affect the life of a machine, the only reliable method of obtaining such data is to procure it from the farmer. Most of the figures available at the present time on the life of farm machinery have not been based on actual records, or have taken into account too few machines of varying characteristics to make the general application of the data presented.

There are two methods by which the above-mentioned data can be collected from the user of agricultural implements: one by a questionnaire sent through the mail; the other by a survey in which the information is secured from the farmer directly. The former has the disadvantages that it is difficult to get a very general response from a questionnaire, and it is difficult to make clear the information sought. These objections are very largely overcome by the latter method.

The engineering experiment station at Iowa State College has a project under way at the present time to determine the depreciation of farm machinery. A survey of the farmers of Hardin County, Iowa, was made by me the past summer. The major part of the data has not yet been compiled into tables or expressed by curves. However, I have been advised that a preliminary report will be published by the station at an early date. The purpose and plan of the survey is as follows:

Purpose. The purpose of the survey was to secure the history of both worn-out farm machines and those that had been in service longer than one year. Only those machines that had been used in typical farming, as practiced by the average Iowa farmer, were considered. The term "history" is taken to include all information pertaining to farm machinery which would be used in determining its depreciation. The following data were secured on the common farm implements: cost, period of service, the number of days used per year, the amount of service rendered per year (expressed in terms common to the type of machine), and the cost of repairs. A record was made of the size of farm, topography, type of soil on which the implement was used, also as to whether it had been housed or painted, and the general appearance of the farm equipment.

Plan of the Survey. The method of investigation followed was to visit farms throughout the state and secure from the farmers or their representatives a record of the above-mentioned data for each farm implement. The survey will be carried on until a sufficient number of records (several hundred or a thousand) for each type of machine have been secured, so that the averages of the various items of data will represent more nearly a true average of actual conditions. The data thus collected will be compiled into tables and expressed by curves for future reference and study.

The Data Sheet. After some study a data sheet, shown in the accompanying reproduction, was drawn up. An effort was made to provide for all the various items that would, in any way, affect the history of the machine. (The sheet should be revised to include type of soil upon which the implement was used; in the data collected up to this time this notation was made under "remarks.")

The Survey. Owing to the late spring, the oat harvest, haying and corn plowing came on in very rapid succession, or, in many cases, at the same time. This condition caused the farmer to be extremely busy and an interview was difficult to obtain; in some cases, next to impossible to secure. The time required to procure the desired information varied con-

siderably. The more important factors were the importance of the work the farmer was doing when approached; the amount of machinery on the farm, and how well the owner had in mind the information sought. (In some cases he would have to think quite a while to recall when the machine was purchased; in other cases it was what he paid for it, and perhaps the most troublesome item was the exact amount of the repair bill.)

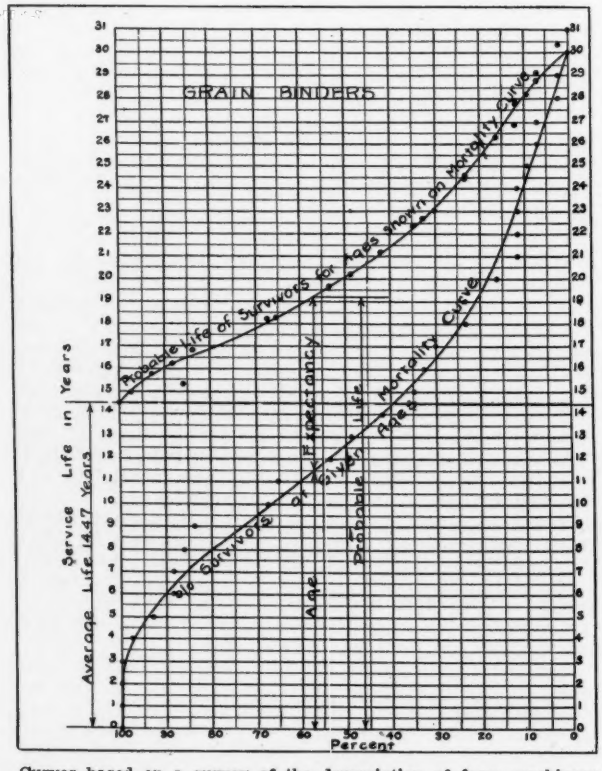
In two cases only was an accurate record kept of the machinery on the farm. In all others the farmer either estimated or gave the information from memory. The first question regarding these statements might be, is such information reliable? A study of the situation brings out the fact that a farmer is perhaps in a better position than any one else to make an estimate concerning his own business. When a large number of records are taken into consideration, the law of averages will likely give satisfactory results, and since the farmers do not keep an accurate record of their machinery, no other practical method has yet been developed to substitute for the one used.

A study of the repairs of the various implements brings out some interesting points; namely, those parts which fail first in the machine and those parts which contribute most to the operating expense. In many instances this may form a basis for suggestions along the lines of improving the machine by a change of design, or reduce the repair of a certain part by better care.

Repairs. A study of the field data sheet gives the following information which includes the averages of both worn-out machines and those still in use:

1. Grain binders: 126 binders of the average age of 12.47 years, varying from 3 to 30 years; 20.1 per cent required new canvasses; 16.3 per cent required new sickles; 4.7 per cent required new guards.

Some of the miscellaneous items were canvass slots, chains, reel vanes, and castings. Twenty-six binders required new canvasses every six years. An inquiry from some of the farmers that were getting rather long service from this item brought out the following valuable information in regard to caring for the canvass: Store in a dry place free from mice and rats, avoid getting wet during use; and loosen tighteners at night.


GRAIN BINDERS
Probable Life of Survivors for Ages shown on Mortality Curve
Mortality Curve
Probable Life of Survivors of Frequency Given at Ages
Age
Average Life 12.47 Years
Service Life in Years
Percent

Curves based on a survey of the depreciation of farm machinery made by Iowa State College

2. Disk Harrows: 131 disk harrows of the average age of 10.62 years; 15.3 per cent required new bearings.

Sharpening was the most expensive item of the operating expense; 122 disks were sharpened on an average of one every 3.36 years. This cost approximately $4.00 per time.

3. Corn Planters: 147 planters of an average age of 9.57 years; 32 per cent required new wire; 17 per cent required new wire trip forks; 6 per cent required new shoes; 5.4 per cent required new tongues; 2.0 per cent required new wheels.

An inquiry from the farmers that got unusually long service from their wire revealed the following valuable information in regard to caring for the wire: Dry the wire before rolling it up, then coat it with lubricating oil and store in a dry place. It is thought that the life of the wire might be prolonged by better care. It was the opinion of those farmers, who did get long service from their wire, that, in most cases, where short periods of service were obtained the wire rusted rather than wore out from use.

4. Cultivators: 226 cultivators of an average age of 9.04 years; 13.7 per cent required new tongues; 335 sets of new shovels required or 1.47 sets per cultivator.

The cultivators were sharpened on an average of once every 2.21 years. Many farmers contended that it was more economical to buy new shovels than to have the old one sharpened and repointed. This probably accounts for the fact that they were not sharpened oftener, also for the rather large number of new shovels purchased. The cost of sharpening and pointing at the local blacksmith shop in many cases was 50 cents less than the price of new shovels. There seems to be a great deal of dissatisfaction with the quality of work done by the local blacksmith. This fact suggests the designing or building a shovel with replaceable point similar to the plow share. No doubt a great deal of good material is wasted as the upper part, which requires the larger percentage of the material which goes to make a shovel, is thrown away when the old shovel is discarded. The saving of this material is a very important item; also the point for the shovel could be manufactured and sold for much less than the price of a new shovel.

5. Plows: 54 gang plows of an average age of 7.76 years; 46 sets of new shares required; 4.19 years average life of a set of shares.

The most expensive item of operating expense was new shares. However, this was followed rather closely by sharpening. Each share was sharpened on an average of once every year. Of course, some farmers sharpened the shares as many as two or three times per year. As mentioned before, there was complaint in regard to the quality of work now being done at the local blacksmith shop. The most general complaint was that the shares were not hardened properly, and consequently did not give satisfactory service.

6. Sulky and Walking Plows: 70 plows of an average age of 10 years; new shares every 3.61 years, sharpened once every 1.97 years.

7. Mowers: 119 mowers of an average age of 10.33 years; 65 per cent replaced sickles; 32 per cent refilled sickles; 14.3 replaced broken tongues; 11.6 per cent replaced sickle heads; 10.9 per cent replaced guards; 5 per cent replaced ledger plates, 225 new sickles purchased (1.89 sickles per mower); 3.57 years average life of sickle.

The replacement of sickles in many cases was due to breakage. This suggests the possibility that the cutter bar was out of alignment or that the guards were bent. On one occasion, where a farmer complained that he could scarcely keep a sickle in his mower, I checked up the alignment of the bar and found it to be over 3 inches out of alignment without any "lead" considered.

8. Wagons: 122 wagons of an average age of 13.93 years. The items of expense and repair were proportioned as follow: 49 per cent had the tires reset; 18.8 per cent required new wheels; 14.7 per cent required new boxes; 10.6 per cent required new reaches; 7.3 per cent required new bolsters.

9. Hay Loaders: 73 hay loaders; 27.2 per cent required new slats; 6.8 per cent required new chains; 5.5 per cent required new crankshafts.

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Engineering Aspects of Forestry*

By Raphael Zon

Director, Lake States Forest Experiment Station, Forest Service, U. S. Department of Agriculture

FORESTRY involves knowledge of biology and of engineering science and skill. A forester, like an agriculturist, is a biologist when he deals with timber crops as growing plants. A forester depends upon engineering skill when he harvests the timber crops, transports logs from the stump to the mill, lays out logging roads, builds sawmills and pulp and paper plants, and converts logs into lumber, paper and other commodities.

In the final cost of lumber, the cost of transportation is probably not less than 75 per cent. A carload of lumber averages about 20,000 board feet. To transport some 34 billion feet of lumber annually cut in this country requires some 1,700,000 cars.

Forest products form not less than 200 million tons of freight annually. Only bituminous coal exceeds forest products in tonnage. The tonnage of forest products exceeds the combined tonnage of all agricultural products. The railroads' revenue from carrying forest products is over $103,000,000, nearly double that received from transporting grain. These figures give an idea of the enormous transportation problem involved in harvesting and distributing the products of the forest.

The transportation of logs from the stump, often in mountainous and inaccessible places, to the mill taxes the ingenuity of the engineer to the utmost. It involves in some places the construction of overhead cables, chutes, flumes, dams, donkey engines, and many other engineering works.

The sawmill machinery, and its adaptation to special uses such as the large logs of the Pacific Coast, is another field in which engineering skill of the highest grade is involved. The laying out of logging railroads, the improvement of drivable streams, all are the work of an engineer.

It is, however, not only the civil and mechanical engineers that are concerned with the use of the forest. The water power engineer, the electrical engineer, the chemical engineer, and the landscape engineer deal more or less with the forest, either directly or indirectly. The prenomenal growths of the lumber industry and the opening of inaccessible regions for logging could never have been accomplished without the skill of the engineer.

Unfortunately, however, the engineering skill of the past, in its relation of forestry, was largely destructive to the forest. The forest was looked upon as a mine to be abandoned as soon as the virgin timber was removed. The engineer's skill was applied to remove this virgin timber as cheaply and efficiently as possible, but without regard to the future of the land in its relation to public welfare.

A new era is coming in which the forest engineer's skill will be applied not to wrecking the forest but to recreating and perpetuating it.

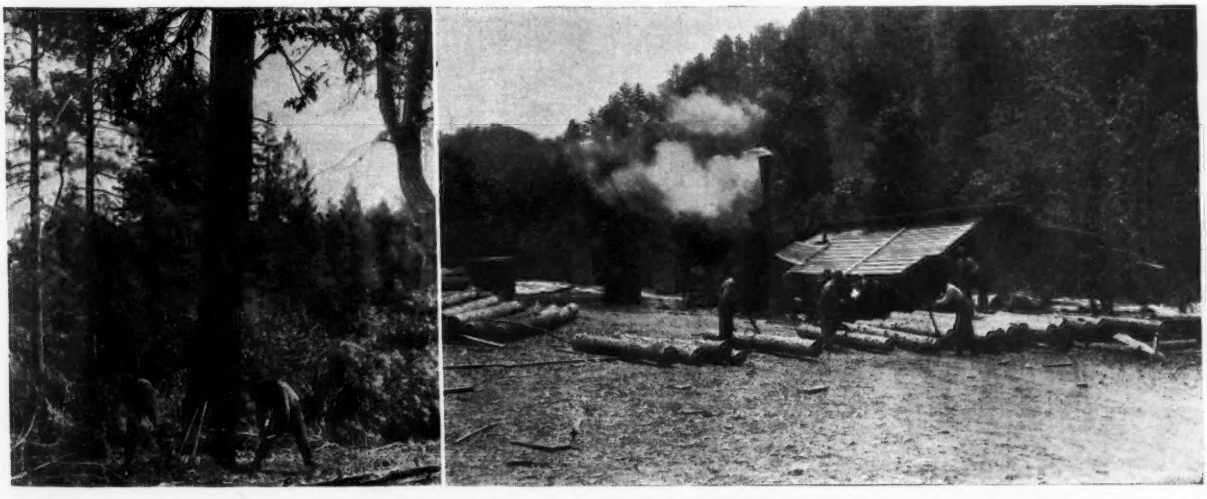
In the utilization of the forest as a permanent resource, the field for the engineer is even greater than it was in the period just past when he contributed largely toward the rapid removal of the forest. In the forest that is to be regrown and used forever as a permanent resource, permanent roads to make the forest accessible are the first requirement. The development of logging machinery, adapted to logging the new timber crops with the least injury to the remaining young trees, is a task that is still before the American engineers.

The mammoth sawmill is passing out of existence. New types of sawmills and wood-using establishments are coming in its place. The one mammoth sawmill, which sawed only lumber and burned what could not be made into lumber, is being replaced by groups of wood-using plants which supplement each other, and in which one plant works with material that the other cannot use.

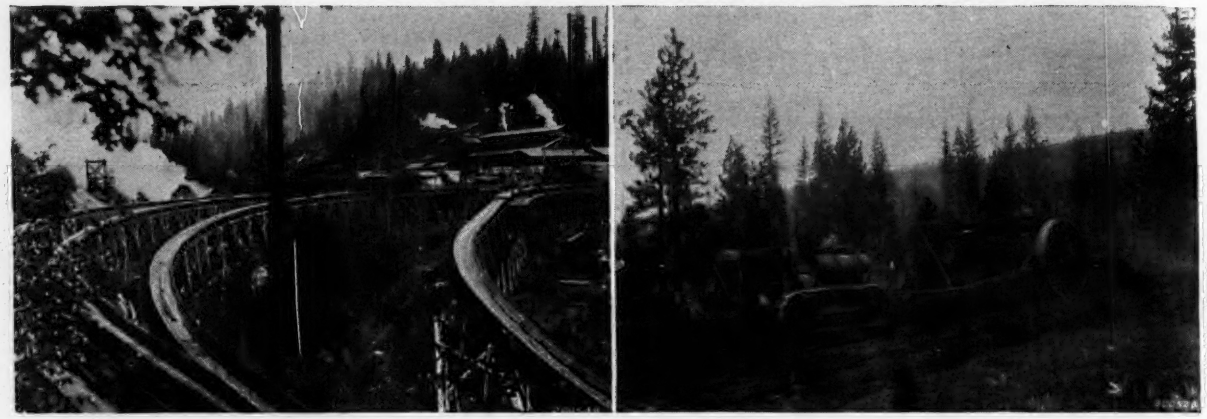
The forest is essentially a diversified crop. In a forest one finds trees of different kinds. Some are best adapted to be sawed into lumber. Others can best be used for pulp and paper making. Still others are turned into toothpicks and clothes pins. Even the same trees may yield different products. The lower part of the tree is suited for sawlog material, while the upper part may be used for pulpwood, and the tops and even the branches for chemical wood. Therefore, only a group of wood-using plants that can utilize the different products of this diversified timber crop can engage in profitable timber harvesting.

What would you think of a packer who would utilize only bacon and ham and throw away the rest of the hog, or of a farmer who was producing milk, beef, pork, corn, wheat and truck products, yet could sell only wheat, thus making wheat carry the entire farm? This has been exactly the case in the past with our forests, and it has made lumbering un-

*Paper presented at the 19th annual meeting of the American Society of Agricultural Engineers at Madison, Wisconsin, June, 1925.



(Left) Felling a giant of the forest in the Coconino National Forest, Arizona. (Right) A portable sawmill operating on government timber in the Cherokee National Forest, Tennessee. (Photos by E. S. Shipp. Courtesy U. S. Forest Service.)



(Left) Flumes of the Madera Sugar Pine Company, Sierra National Forest, California. (Right) Logging with a "Caterpillar" and big wheels, Lassen National Forest, California. (Photos by W. I. Hutchinson. Courtesy U. S. Forest Service.)

profitable or much less profitable than it might otherwise have been.

A forest that is worked only for the choicest veneer logs and nothing else cannot be definitely a paying proposition. It is only when each part of the tree or each kind of tree is put to its best use that timber cropping becomes a profitable enterprise.

Another type of sawmill which has a promising future is the small plant driven by electricity, generated by water power, which cuts only the annual growth of the tributary timber and therefore will have a permanent life. Many a forest has been wrecked before logging has even started because the sawmill built by engineers was far beyond the capacity of the forest to sustain by annual growth. To feed the sawmill not only the growth but the entire forest had to be cut and the forest capital was destroyed in the process. The timber owner built a Moloch and then had to bring as a sacrifice the present and the future of the forest.

Another type of sawmill that is coming to claim the attention of engineers is the protable sawmill. This type of sawmill is of particular interest to small woodlot owners or farmers. In many localities, like the New England states, where many an abandoned pasture has come up to second growth white pine, it is the most efficient means of harvesting the crop. This portable sawmill, however, may be a blessing and it may also be a detriment to the owner of the small woodlot.

A small portable sawmill, usually equipped with a circular saw, produces large proportions of rough lumber of inferior grades. As a matter of fact, the product of a portable sawmill is seldom graded and therefore brings only a low price on the market. When a woodlot owner has some fine old timber of oak, hickory, and other valuable species, and it is sawed up by a portable sawmill operator, the chances are that the product coming from high-grade logs is greatly degraded.

It is, therefore, important for every woodlot owner to consider carefully, when he has timber to sell, whether it would pay him better to sell his high-grade logs to an efficient sawmill or to have them sawed by a portable sawmill and try to sell his ungraded lumber in the open market. My own experience shows that a farmer can do much better in such cases to sell his logs to an efficient sawmill, as he will get a higher return by selling the logs than by having them sawed by a portable sawmill and then selling the lumber.

On the other hand, if a farmer needs some rough lumber for a barn or some other rough construction, and he has timber of his own, it might be cheaper for him in the long run to have a portable sawmill saw his timber than to buy lumber at a retail lumber yard at high prices.

An individual owner of a woodlot, however, in every case is at a disadvantage in comparison with a large timber owner. The solution for the woodlot owner lies in cooperative marketing of his woodlot products. If cooperating marketing is essential for the farmer in his agricultural products, it is even more essential in the case of his woodlot products. As a rule, a farmer knows better the value of his hogs, his corn, or his wheat, than he knows the value of his timber crop. He is likely to be cheated in many ways.

There are forty-four different log rules by which timber may be estimated. Some of them give high values for large timber and very low values for small timber. Others are more advantageous to the buyer than to the seller. Sometimes the farmer may receive apparently a high price for his logs, yet when the underrun of the log rule is considered, he obtains but a small price for his total product. Sometimes the farmer may have a few trees, such as black walnut or yellow poplar or oak, but yet not enough to ship to a distant sawmill because it does not make a full carload. If farmers of a certain locality would pull together and handle their woodlots on a cooperative basis, they could hire a reliable man who could advise them as to the kind of log rule to use so as to get the greatest value from their timber and the best use for which they could sell it. I have seen many splendid white oak logs, that would saw out high-grade veneer and bring high prices, sold for bolts to be made into tight stave cooperage which brings but a few cents. By cooperative marketing in carload lots, each individual farmer could get a much higher value for his product and, through the advice of the expert, have his woodlot left in a much better growing condition than it was before.

Therein lies a distinct obligation on the part of the engineer to devise a portable sawmill or a method of transportation for the farmer's woodlot products that would net him the highest possible return on his woodlot crop. The agricultural engineering departments at many of our colleges give a great deal of attention to agricultural machinery—separators, plows, threshers, and what not. How many agricultural engineering departments have given a thought to the portable sawmill, particularly adapted to the needs of farmers in a given region? This is a field which so far has received but scant attention on the part of agricultural engineers and a field in which our county agents can be of immediate and direct benefit to the farm woodlot owners.

Engineering skill is involved in the utilization of forest products. Within the last few decades there has been a phenomenal growth of the chemical wood industry, in the use of the wood either for the production of pulp and paper or for the chemical by-products, like acetic acid, methyl, and quite recently ethyl alcohol, acetone and others. The chemistry of cellulose is still in its infancy and the field is practically unlimited.

The water power engineer has a direct interest in forestry since the forests regulate stream flow and protect the watersheds.

The sanitary engineer, especially if he is concerned with municipal water supply, finds in the forest the best purifier and protector of the water.

Wood is such an important construction material that the

(Continued on page 63)

An Extension Project in Farm Drainage

By Ralph L. Patty

Mem. A.S.A.E. Professor of Agricultural Engineering, South Dakota State College

A PROJECT in farm drainage has been carried on in agricultural extension in South Dakota for the past seven years, the purpose of which has been to encourage the application of proper methods to farm tile drainage.

A good authority has estimated that forty per cent of the money that has been spent in the older states on the drainage of farm land in the past was wasted. If this is true it has meant the waste of a very large amount of money, because records show that forty-nine million dollars have been spent on this work in one corn belt state alone.

Three mistakes have been responsible for most of this wasted money in the past: (1) Laying too small tile; (2) laying tile by guess instead of to an engineer's grade; and (3) laying tile into a pond and expecting them to work like a culvert instead of carrying them deep under the bottom of the flat.

Plan of Project

The plan of the project is to show the best practices in draining farm land with tile, and to show how those practices are best. In doing this, one tile drainage system is made a demonstration for an entire community covering an area equal to from two to four townships. The installation of each one of these systems is closely supervised, carefully planned and closely checked up after the tile are laid. A competent tiler is secured for doing the work, who can lay tile to an engineer's grade and who is willing to do the work subject to the checking up and inspection of the engineer. About the time the tiler is finishing his work and the lines are ready for the engineer to check up, a field meeting is arranged and anyone interested is invited to come over at the appointed time. While the tile are being checked up to see that they have been laid to grade, that the connections have been properly made and outlet protections installed, the importance of all these things and other good practices are discussed. This is the best time for the neighbors to look the system over because they can see the tile in the trenches ready to be covered. They can observe the size of tile and find out how this size was figured and why. They can see how deep they were laid at various parts of the system and know the reason for it.

How a Typical Demonstration was Installed

A typical demonstration project would be carried on in the following way: J. Smith has a series of sloughs and wet land cutting up his fields, wasting good farm land and interfering with cultivation. He speaks to the county agricultural agent about it. The next time the extension agricultural engineer is in the county the county agent takes him out to Mr. Smith's place. Field instruments are taken along and a preliminary survey of the project is made to see if there is enough fall for a good outlet. Stadia readings are taken to get the distances so the amount of tile needed will be known. The size of tile necessary to handle the flood water before the crop is drowned out is figured. The soil is examined to find out the most economical depth and spacing for lateral tile on the flats. From this information a very close cost estimate is given the owner. Has the owner agreed to go ahead with the project yet? No, because it isn't fair to ask a man to agree to any improvement until he knows what it will cost him. Now he can decide because he knows what it will cost.

Suppose the cost figures are too high for him. Has the time and work of the extension engineer and the county agent been wasted? Certainly not. The complete report of this preliminary survey with the number of feet of tile needed and the cost estimate is made out and each party keeps a copy of it. Such a report is good for many years and valuable to the owner. Twenty-five years from now he can have the cost estimate changed to the current prices of tile and labor and know exactly where he stands.

But if he decides to put in the tile and his farm is in a community where there is not already a demonstration project, then he can order his tile when he is ready. When the tile are on the ground the entire system is staked out and the figures for the grade are furnished him. He secures a competent tiler who begins digging the trench and laying the tile. This may be done with a trenching machine or by hand.

When the tiler is finishing up the work a field meeting is called and the tile are checked up to see that they are right. The tiler is asked to lay a few of the last tile to show how tile are laid to an engineer's grade by means of targets. This is an interesting part of the field meeting. It is safe to say that any farmer who has seen these tile laid to grade and who has seen the true, even grade to which they can be laid when targets are used will never waste money in having tile laid by guess.

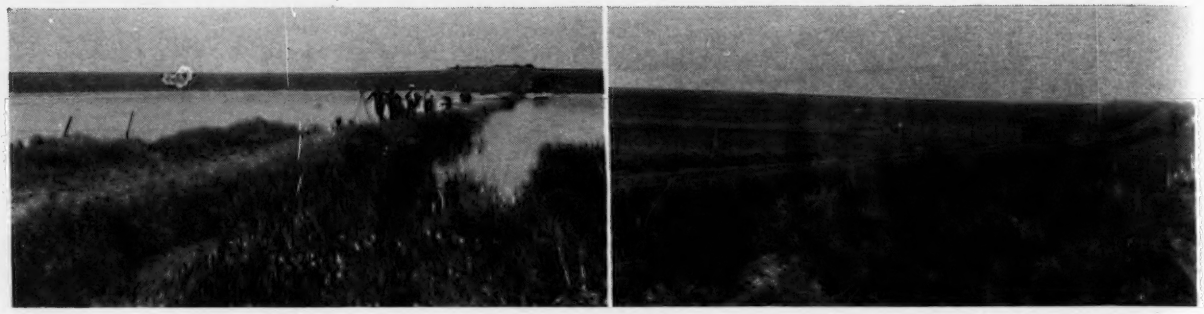
After the system is completed the neighbors can watch the crops grow on this land in the years that follow and decide for themselves whether or not it pays to put in such improvements in the right way the first time.

Just the past season a man from Illinois said to the writer, "Yes, tile are a fine thing while they last, but they soon fill up with dirt." This man had observed work that had been done the wrong way. Perhaps the tile had been laid by guess with sags in the grade. Perhaps too small tile had been used for laterals. It is true that a three or four-inch tile will sometimes clog, even when laid to a fairly good grade, owing to so small an aperture and the trouble from trash. For this reason these sizes have largely been discontinued for draining farm land.

How Long Will Tile Last?

Tile that were laid in New York state in 1835 are still doing the work. C. G. Elliot, a well-known drainage engi-

(Left) A wet flat on the farm of Moses Thomas, Miner County, South Dakota. The picture was taken in a dry season, but the wet land cut an entire field in two and wasted about fifteen acres of land. (Right) The same field raised a crop of flax the year after it was drained and this field of corn the second year. The entire system of tile drainage here cost $510



Farm land can be drained and good roads made at the same time with drain tile. This road grade was reclaimed together with ten acres of good farm land for $395. A grade alone would have cost $500, and that would not have included maintenance. The left view shows the condition before drainage, and the right view after. Washington Township project, Clark County, South Dakota

neer and author, is authority for the statement that drain tile laid on the John Johnson farm in western New York in 1835 are still in good condition and working every season. These tile were made from clay and made by hand. The hard-burned clay tile of today should last much longer.

The farm lands of the Northwest are well dotted with ponds and sloughs of various shapes and sizes. This land is the best and most productive soil we have when it is drained. It is full of vegetable growth, rich in humus and latent plant food. A good system of under drainage loosens up the soil particles, introduces air, and raises the soil temperature. These factors encourage the action of soil bacteria and they in turn work on the roots and vegetable growth causing them to decay and liberate the plant food. When drained, this wet land is better in both wet and dry seasons. It is insured land if the work is properly done.

Drained Land is Better in Dry Seasons

There are two very good reasons why land that is tiled is better in a dry season. One reason is that the crop can be put in earlier in the spring and with a better seedbed; the other is that the drainage loosens up the soil particles so the soil will absorb and hold more moisture. A sponge will absorb and hold more water than tightly woven cloth. This is because there are more pores in it. For the same reason loose soil will hold more moisture than tight soil of the same structure. The soil particles of low land that is undrained are usually run together and will hold less moisture.

Good Practices in Laying Tile and Why

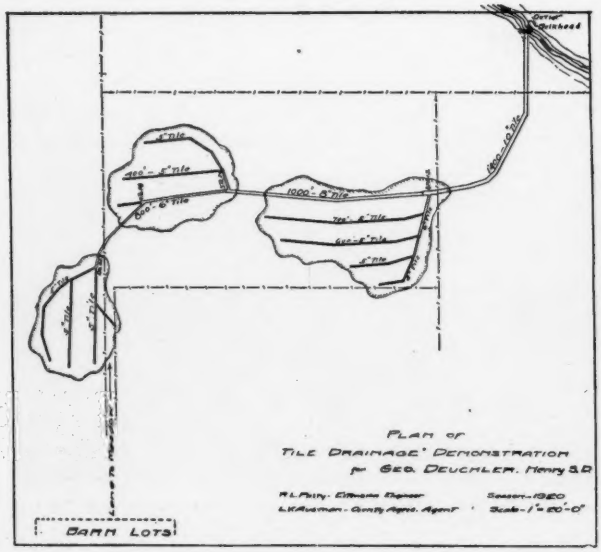
The good practices that are emphasized in the South Dakota demonstrations are: (1) The laying of tile to an engineer's grade, (2) the economical plan or layout of the system, (3) the use of tile that are of the right size, (4) the proper spacing and depth of lateral tile for the type of soil, (5) proper connection of branches, and (6) proper protection for the outlet.

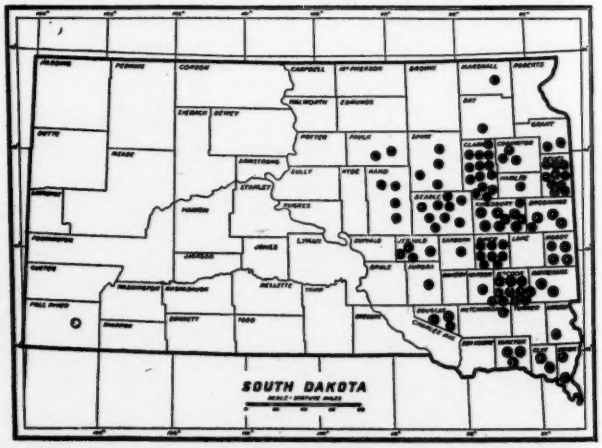
The Engineer's Charge a Paying Investment

An experienced agricultural engineer on most projects will save many times the cost of his services. On many jobs the running of the grade alone will save it in the amount of digging labor, beside the advantage of having a true grade. Often he can more than save his charge in checking-up the tile after they are laid and having mistakes corrected. But this instrument work is only a small part of his services. He knows how to lay out a system so it will do the most good with the smallest amount of tile. He knows the difficulties that must be avoided, such as danger from tree roots, heavy grades, and seepage water. And he knows how to figure the proper sized tile which, when laid on a certain slope or grade, will carry the flood water off in time to save the crop. Many systems of tile over the country have been laid out in such a way as to use more tile than necessary. In systems where a considerable number of lateral branches are used, it is often possible to reach the same ground with one-fourth less tile by means of a good plan.

Drain Tile that are Too Small, Little Better than None

A tile drainage system with a capacity that is too small is an aggravation and little better than none at all if the land is to be used for cultivated crops. Nine times out of ten the land will be used for cultivated crops even though the original purpose was only to make hay or pasture land out of it. If the main tile is too small the crop in the flat will be drowned out about once every so often, and the loss of this crop and labor is usually equal to the net profit from the crops that are taken from it when it does raise a crop. As a result the project shows no profit and the land might as





This map shows the plan of a demonstration drainage system on the farm of George Deuchler, Codington County, South Dakota. The gridiron system of laying out laterals was used. This chain of ponds is typical of conditions in South Dakota where farms are cut up and the land wasted. About fifteen acres of land was wasted in this case. After they are drained they cannot only be cultivated but the land is crop insured

The fruit of a drainage system is borne on its branches, and if the branches are not provided, there will be little fruit.—R. L. Patty

well be left under water. In fact, long experience has shown that it never pays to drain farm land unless the tile are large enough to insure a cultivated crop.

Why Drain Tile Should be Laid Deep Under the Slough

One of the great wastes of money in laying drain tile that was mentioned above was the method of laying them as shallow as possible, so they would just come to the top of the ground in the lowest part of the slough. At first glance it would seem as though this would work satisfactorily since the tile line would carry off the flood water just like a culvert. Thousands of installations of this kind have shown the method to be a failure. In the first place, these tile cannot carry off any more than the surface water at the very best, and in practice it requires a very long time for them to carry off the last of the surface water. In wet times water continues seeping in from the edges, and since the opening to the tile is usually near the center of the pond this seepage water must move across the flat from all sides to the inlet. It moves very slowly. All this time the ground is full of water, and in most cases the crop is ruined before the ground water has a chance to soak down and give the plant roots some air. Tile that are laid three to four feet below the surface in the bottom of this same slough draws the water out from below. After a heavy rain it carries off the surface water and then continues drawing the surplus water from the soil down to the depth of the tile. In this way it is making a reservoir below the surface which will be able to absorb the next fair sized rain without any of the water standing on top at all. This kind of tile drainage is crop insurance. It is the kind that benefits the soil as described above.

The number of tile drainage projects installed as demonstrations in South Dakota in the past seven years totals one hundred three. These are scattered over about thirty counties. Four hundred and seventy-four preliminary surveys have been made and recommendation and cost estimates furnished on them. Land owners over the state are closely watching the completed projects and the crops that are growing on the drained land. During the past three years the number of tile drains laid "by guess" that have come to the attention of the writer can be counted on the fingers of one hand. The eastern half of the state is well covered with sloughs and small ponds, ranging in size from one to forty acres, and this land will all be drained eventually.

The purpose of the project is not to hasten this work particularly, but to show the best way to do it when it is done. More public outlet systems of open ditches or large tile will be necessary before it is all drained, but they furnish outlets primarily and actually drain a small percentage of the farm and thoroughly. It is the returns from the cultivated land on the farm that is drained that must pay for the improvements, and unless the farm land is properly drained the outlet system does not begin to serve its purpose.

South Dakota has 481,000 acres of wet farm land according to the last census. This land will eventually be drained. At present costs fifteen to twenty million dollars will be spent in doing this work. If forty per cent of this money is saved to South Dakota by the drainage project of the extension service of the state college, outlined in this article, it will amount to a considerable sum of money.

Potato Digger Saves Labor

THE potato digger is a labor-saving machine that is proving itself in the Kaw Valley of eastern Kansas, which has become noted for its potato crops. Last year in the eleven counties that make up the Valley a total of 19,462 acres were devoted to potatoes with a total production of 2,492,230 bushels valued at $1,724,832.

The Kaw Valley crop, which is made up largely of Irish Cobblers, is produced in July. The mechanical digger enables farmers in this region to allow their potatoes to remain in the ground for some time after they have attained their growth—in ground storage, as it were—until the prices are right and then to dig them out in quantities for quick shipment.

In the accompanying illustration is shown a potato digger pulled by 10-20 tractor and owned by J. W. Luthye of Silver Lake, Kansas. Mr. Luthye operates a 120-acre farm, and the past year had 68 acres in potatoes. With a tractor and potato digger shown eight to ten acres of potatoes can be dug in a day. This outfit digs enough potatoes to keep 35 to 40 boys or women picking them up and sacking them.

A tractor-drawn potato digger greatly speeds up the harvesting of the potato crop

Irrigation Investigations in Texas*

By R. G. Hemphill

Mem. A.S.A.E. Associate Irrigation Engineer, U. S. Department of Agriculture

THE purpose of this paper is to tell something of the work being done in Texas by the division of agricultural engineering of the U. S. Department of Agriculture and the Texas State Board of Engineers. These two agencies have, for a number of years, cooperated in investigations which have for their ultimate object the maximum development and use of the irrigation water resources of the state.

Everyone knows that successful irrigation increases the wealth of a community, but few realize the magnitude of the increase. Some idea may be obtained, however, from a comparison of figures for the value of property in two Texas counties, Hidalgo and McMullen, both of which are in the area of low rainfall and require irrigation for successful farming. In McMullen County, where no irrigation development has taken place, the total value of all farm property increased from $1,400,000 in 1900 and $9,400,000 in 1920. This is an increase of 670 per cent and is comparable with the increase of 560 per cent during the same period in Ellis County, one of the best farming districts of that part of the state where irrigation is not required. In Hidalgo County large areas were brought under irrigation subsequent to 1906, and there the value of all farm propery increased from $2,700,000 in 1900 to $45,000,000 in 1920, or 1660 per cent. Thus, for farm property alone, the rate of increase with irrigation was two and one-half times the rate of increase without irrigation. When the value of all property is considered, the difference is even greater since McMullen County remains almost entirely a cattle-raising district, while there are in Hidalgo County a dozen flourishing towns and a number of industrial establishments which owe their existence chiefly to the development of irrigation. Census figures for 1922 show the actual value of all tangible property in the state to be three times its assessed value for taxation. If this ratio holds good for the two counties, the assessment figures for 1923 indicate a total actual value of $85,000,000 for Hidalgo County property as against a total actual value of $9,500,000 for McMullen County property. Even if the general ratio is not strictly applicable to the two counties, there can be little doubt that the rate of increase with irrigation was not less than five times that without irrigation. Had Hidalgo County continued without irrigation and developed at the same rate as McMullen, the total value of all property in the county in 1923 would have been $17,000,000 instead of $85,000,000. It seems reasonable, therefore, to credit to irrigation a gain of $50,000,000 or more in value. It is interesting to note that this gain, which is only a part of what may be expected eventually, was brought about by a capital investment of only $8,000,000.

But these figures do not tell the whole story. Comparing the two counties from a social standpoint reveals an equally striking difference. During the period from 1900 to 1920, the population of McMullen County remained at approximately 1000, and there was little change in living conditions. But in Hidalgo County the population increased 31,000, which, on the basis of five persons to the family, means a net increase of not less than 6000 homes, and what was once range country similar to that in McMullen County is now covered with prosperous communities with fine churches, excellent schools, the best roads, adequate rail transportation facilities, electricity for lights and farm power, water for domestic use, telephones, ice, and the other necessities and conveniences which make for a fuller and more comfortable life. Such properous farming communities are the state's greatest asset.

It must be clear to anyone who gives the matter any thought that where the supply of water is limited, as it is in Texas, and where such tremendous benefits result from its use, there can be no more important work than research which has for its object the determination of the facts which must be the basis of the sound and efficient conservation and utilization of this most valuable resource of the state.

The research work of the U. S. Department of Agriculture and the Texas Board of Water Engineers along this line falls under three heads: (1) Duty of water, (2) canal losses, and (3) silt in Texas streams.

Duty of Water

From the standpoint of irrigaiton, every water supply, whether of a river, canal, or farm ditch, raises the questions: How much land does it irrigate? and, How much land should it irrigate? This relation between water and land, commonly expressed as the duty of water, is involved in every phase of irrigation. It is one of the fundamentals which must be dealt with (1) by the irrigator in his endeavor to control soil moisture in such manner as to produce the maximum profit from his agricultural operations; (2) by canal managements in preventing the excessive and wasteful use of water; (3) by engineers in determining the capacity of irrigation structures; (4) by water administration officials in promoting the maximum utilization of water resources; and (5) by the courts in the just determination and settlement of water right.**

The term "duty of water," defined as the relation between a quantity of water and the area of land it serves, is usually qualified to indicate the point at which the water is measured. Thus, net duty is measured at the edge of the farm or field irrigated and is generally understood to include small losses such as a minimum run-off at the lower end of the field and some percolation below the root zone of the crop, which can rarely be avoided even under the best farm practice.

When not affected by plant diseases, insect pests, and other accidental factors, the yield of crops under irrigation depends chiefly on the soil, the time of irrigation, and the amount of water applied. When water is so applied as to eliminate controllable losses, increasing quantities will produce increasing yieds; but, with a few exceptions, there is for each crop and soil a depth of water which will give an approximate maximum yield of good quality, and the application of a greater depth not only fails to increase the yield but may, and often does, cause a reduction in both yield and quality. Experiments to determine this depth or maximum duty for various crops under the climatic conditions which prevail in south Texas were conducted by the U. S. Department of Agriculture and the Texas Board of Water Engineers at Mercedes, Crystal City, and Natalia.

In carrying out the experiments the procedure was to plant an area in each crop and to divide this area into three plots, or sections, for comparison. In order to approximate field conditions as closely as possible, small plots were avoided and the majority ranged from a quarter of an acre to an acre in size. All operations on the three plots from the first preparation of the soil to the harvesting of the crop were done at the same time and in the same manner, the only variation in the treatment accorded being in the amount of water applied. To the middle plot was applied an amount of water which it was believed would produce the best returns. To one of the remaining plots a larger amount was applied, and to the other a smaller amount. Under this procedure the difference in crop yield from the plots should be due chiefly to the different quantities of water applied.

From these experiments the proper duties expressed as depths applied, for various crops under south Texas conditions, were determined to be as given below. The figures include

*Paper presented at a meeting of Southwestern Section of the American Society of Agricultural Engineers, at College Station, Texas, May 15, 1925.

**Samuel Fortier, Duty of Water Irrigation. Address before International Engineering Congress, San Francisco, 1915.

water received from irrigation and from rains which amounted to more than 0.25 inch or less than 4.00 inches. Rains of less than 0.25 inch scarcely wet the soil and the moisture is quickly dissipated by evaporation. Of the heavy rains it was assumed that not more than 4.00 inches entered the soil and became available for the growing crop. Any excess above that amount was therefore not included.

Corn on sandy soil	15 to 20 inches
Cotton on sandy soil	15 to 18 inches
Cotton on loam	14 inches
Sugar cane on clay soil	55 to 60 inches
Rhodes grass on sandy soil	6 inches per crop
Sorghum on sandy or clay soil	9 inches per crop
Cabbage on clay soil	18 inches
Lettuce on loam	10 inches
Lettuce on sandy or clay soil	10 to 12 inches
Cauliflower on sandy or clay soil	15 inches
Tomatoes on sandy soil	14 to 17 inches
Tomatoes on clay soil	14 inches
Beets on clay soil	10 to 12 inches
Carrots on sandy soil	12 inches
Snap beans on sandy soil	12 inches
Snap beans on clay soil	10 inches
Spinach on loam, sandy, or clay soil	10 to 12 inches
Cow peas	10 inches
Watermelons	15 inches
Sweet potatoes	22 to 25 inches

Tests with Pima cotton, a long-staple American Egyptian variety, indicated that this type cannot be grown with profit under boll weevil conditions. A single test with sugar beets gave yields low in sugar content and with a coefficient of purity below the minimum required by sugar manufacturers, thus indicating that the soil and climate of the locality are not adapted to the production of this crop for commercial purposes.

Canal Losses

In its work of granting permits to use water for irrigation, the Texas Board of Water Engineers is called on to estimate the losses which may be expected to occur in the canal system to be built. If this estimate of loss is too high it tends unjustly to restrict appropriations which may be made later; if too low, it may lead to the granting of permits for the use of water in excess of the total available supply in the stream. A knowledge of unavoidable losses is necessary for the correct design of canals and is also necessary for their efficient operation. Very few measurements of canal losses have been made in Texas, and the need of more information along that line led to the investigation of the amount, location, and possible means of reducing or preventing seepage and leakage losses in canals. Field work was done on the Medina canal near San Antonio and on the Mission and San Benito canals in the lower Rio Grande Valley.

Briefly, the field work of this investigation included: (1) Spot measurements of losses in selected sections of canals of all sizes; (2) losses in sections of canals cut off from the remainder by tight dams; (3) losses in hollow cylinders shoved into the banks and bottoms of canals; (4) measurement of the total flow at the head of the canal; (5) determination of the actual amount of water used in the irrigation of various crops; (6) determination of the areas affected by seepage, and the mapping of these areas; and (7) a study of the fluctuation of the ground water level by the aid of observation wells.

For the spot measurements, long stretches of canal of uniform cross section with no inflow or outflow were selected and after the discharge had been held steady for a number of hours, measurements were made at the upper and lower ends of the section. Measurements in the smallest ditches were made with portable galvanized iron weirs, while the larger discharges were measured with Gurley-Price, Ott, or Hoff current meters. The selected stretches of canal were cross-sectioned at suitable intervals to permit the loss to be stated in terms of cubic feet per day per square foot of wetted area, as well as a per cent of the flow per mile. In the lower Rio Grande Valley where canal grades are flat and velocities very low, losses were also determined in some instances by filling a lateral with water, cutting off a section with a tight dam, and noting the drop in water level due to seepage.

The hollow cylinders used were made up in sets of three, ranging in diameter from 6 to 12 inches and were of stiff galvanized iron. In making a test the three cylinders were shoved about 6 to 8 inches into the silt deposit or original soil of the canal bottom or bank and were then filled with water to the approximate level of the canal water surface. Hook gages were attached to the cylinders and the drop of the water surface measured at intervals. The chief possibility of error in these measurements lay in the chance of disturbing the soil as the cylinders were sunk, but by the use of three cylinders the majority of such errors could be detected. Measurements made by this method agreed very closely with those by other methods.

A continuous automatic record of the discharge at the head of each of the three canals was obtained to determine the gross duty of water under the canal. To determine the net duty a record was made of all the water used on the various crops on a half dozen farms under each canal, and in addition a large number of individual measurements were made of the depths applied in single irrigations of crops on other farms. These figures for the net duty taken in connection with the gross duty give the total transmission loss in the canal.

To throw some light on the course of the water after it seeps from the canal, a number of observation wells were put down at San Benito to a depth of 6 to 10 feet and records of the fluctuation of the ground water level were obtained for a period of nearly a year.

A report of this investigation is now being worked up. On the Medina system the canal losses were found to be comparatively small, the total for the entire system being estimated at 34 per cent of the total supply. In the lower Rio Grande Valley the farmers were found to be using the water with considerable care and getting a fair duty from it, while the canal losses were very high, averaging about 70 per cent of the supply. This high loss may be attributed to the reservoir type of canal with its excessive wetted area and consequent heavy seepage in sandy soil; leakage through gates carelessly closed or needing repairs; overtopping of banks when the supply has not been properly adjusted to allow for decreased use; and a low effieciency in operation due to incomplete settlement and widely scattered small farms, delivery to one and two-acre fields, part-time ditch riders, and the scarcity of checks and measuring devices to control distribution to laterals. Some of these losses can and should be prevented at the present time, but others must continue until a denser population, and increased value of water, and the wealth of the community make a lined canal system economically feasible.

Silt in Texas Streams

With few exceptions the streams of Texas are fed chiefly by the direct run-off from rains and their flow is characterized by quick, heavy floods between which there are long periods of little or no flow. Without a reserve supply of water, irrigation development must be limited to the small acreage which can be handled by the normal low flow of the streams during the crop growing season. As the discharge during these periods of low flow is only a small part of the total annual discharge, full use of the annual discharge can be secured only by the construction of reservoirs to store and hold for later use the water of floods which would otherwise go to waste. All streams carry more or less silt, particularly during high floods, and before any project involving the storage of water on a stream can be declared feasible the probable life of the reservoir, or the period which will elapse before its effective capacity is destroyed by deposits of silt, must be known. Reliable data on the amount of silt carried annually by the stream at the proposed site are necessary for a dependable estimate and may be of great value in doubtful cases as a basis for so adjusting the size of the reservoir to other conditions as to give it a long life and at the same time make it economically feasible.

Some silt determinations have been made in the state by the U. S. Department of Agriculture and a large amount of work has been done by the U. S. Bureau of Reclamation in connection with the silt problem on the Rio Grande project, but the need of more information applicable to other streams of the state led to a further investigation of silt in Texas streams.

It was realized that it would be impossible with the funds available to make a complete investigation of all streams of the state, and for that reason it was decided to confine the greater part of the work to a single-drainage basin. The Brazos was selected as representing most closely the various conditions of soil, typography, and rainfall found over the state, and sampling stations were established at the following points:

Brazos at Rosenberg
Brazos at Waco
Brazos near Glenrose
Brazos near Mineral Wells
Brazos at Seymour
Salt Fork near Aspermont
Double Mountain Fork near Aspermont
Clear Fork near Eliasville
San Gabriel at Circleville
Little River at Little River

At the beginning of the investigation a large number of samples were taken in many cross sections of the stream under widely different conditions of silt content and discharge in order to determine if the average per cent of silt in the entire cross section could be determined from three to five samples. It was found that in a vertical section the percentage of silt at six-tenths of the depth was approximately the same as the average for the entire vertical as determined from four to six samples, the mean variation between the percentage shown by the single sample at six-tenths of the depth and the average percentage of the several samples being only 3.7 per cent. It was then found that by dividing the width of the channel in six parts, and taking samples at six-tenths of the depth at the first, third, and fifth division points, the average of the three samples approximated very closely the average for the entire cross section as determined from thirty to sixty individual samples, the mean variation between the two average percentages being only 3.1 per cent, and the maximum variation only 5.4 per cent. Individual samples taken at the same time and place in the cross section showed as great a variation as this and, therefore, for the routine work it was assumed that nothing would be gained by taking more than three samples for a single determination.

A set of three samples is taken at least once each day at each of the stations listed. The sampling device is a weighted holder which is swung from a bridge with a long cable. An eight-ounce, small-mouth bottle is fastened to the holder and lowered until the mouth of the bottle is at the desired position in the stream when the cork is pulled and the bottle allowed to fill with the silty water. It is then drawn up, corked tightly, and mailed to Austin. At Austin the majority of the samples are weighed, filtered, and dried in an automatic electric oven at a temperature of 110 degrees Centigrade to determine the weight of dry silt in the sample. However, the engineer is concerned chiefly with the space the silt will occupy when deposited in a reservoir, and it is therefore necessary to establish a relation between the weight and the volume. To do this the remaining samples, one or two each week from each station, are poured into glass tubes with a uniform bore of ¾ inch. The silt is allowed to settle for periods ranging from a week to several months thus determining the volume of wet silt. The sample is then filtered and dried, and the dry weight of silt determined. This gives for the same sample the percentage by volume and by weight and establishes a definite relation between the two for a fixed period of settling.

Another method we are using consists of cutting out a three-inch cube of silt from deposits in place, weighing and drying out to determine the weight of dry silt. A large number of such tests have been made and it has been found that the majority of deposits will show a weight of 80 to 90 pounds of dry silt to the cubic foot.

Other phases of the investigation include: (1) A further study of the distribution of the silt in the stream in connection with the design of headworks to control the amount of silt taken into canals; (2) the measuring of the amount of sand and silt rolled along the bottom of stream beds; and (3) the measuring of the amount of silt actually deposited in one or two representative reservoirs during a definite period. Preliminary work along the latter line on a north Texas reservoir indicates a silt deposit of 950 acre-feet each year, or the equivalent of a silt run-off of approximately one-half acre-foot for each square mile of drainage area. It is probable that no higher rate than this will be found in the state.

During the past year several thousand samples have been taken in the Brazos basin and as soon as discharge records of the U. S. Geological Survey are available the total volume of silt carried by the stream during the year can be computed. It is unfortunate that, due to the long dry spell only recently broken, the flow of the stream was not nearer to the normal.

This is not a picture of a banquet of "dirt farmers," but a country style "dinner" of the North Atlantic Section of the American Society of Agricultural Engineers in connection with the meeting held at Schenectady, December 10, 11, and 12, 1925. President Wirt says of this affair: "I think it was the best A.S.A.E. banquet I ever attended. It was a full dress affair, the dress consisting of straw hats and overalls, and with coats off and sleeves rolled up; old-fashioned red and white tablecloths and napkins were used, and the food served in typical country style. It was a typical threshing dinner, with too much to eat and all of it tempting. In the two hours from eight to ten more fun was crowded in than could usually be expected at half a dozen banquets."

Research in Agricultural Engineering

A department conducted by the Research Committee of the American Society of Agricultural Engineers

National Agricultural Engineering Research*

By R. W. Trullinger

Mem. A.S.A.E. Specialist in Agricultural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

THE purpose of this paper is to define national agricultural engineering research and to show how it may be recognized by an analysis of existing investigational activities. Attention is also drawn to a few typical examples.

What is National Agricultural Engineering Research? Research in agricultural engineering consists of at least two phases which are interdependent and necessary to the attainment of ultimately practical results. The first phase has to do with the evolution and development of fundamental agricultural engineering principles which are broadly applicable to the national requirements of the agricultural industry for engineering assistance. The second phase has to do with the further development in detail and possible modification of these principles to make them specifically applicable to the local problems of each state. The first phase therefore seems naturally to comprise the most of what may be termed national agricultural engineering research.

The second, or local, phase originates in the advancement of definite requirements for engineering assistance by the local agricultural industry of each individual state. So long as sufficient engineering knowledge is available to meet these requirements fully and satisfactorily, the work does not need to advance beyond the second or local phase. However, when available engineering knowledge is inadequate, and especially when similar inadequencies become evident in several states, the work must advance into the first phase. It then becomes national in character to the extent that the results are nationally applicable.

The Existing Research Organization. There are forty-eight state agricultural experiment station organizations. Not all of these experiment stations are engaged in agricultural engineering research. However, it would seem that they are all potentially available for some appropriate features of such work. In addition there are some twenty-eight engineering experiment stations in land-grant institutions. A few of these are known to be engaged in a certain amount of agricultural engineering research. Some of the land-grant colleges are also known to be engaged in certain features of agricultural engineering research entirely independently of any experiment station.

All in all, a quite tremendous organization exists throughout the nation which is potentially available for research in agricultural engineering. Advantage has already been taken of the facilities offered by a large percentage of the agricultural experiment stations for agricultural engineering work of local significance. It would seem, therefore, that plans might be laid for taking advantage of these available facilities for a certain amount of work of a national character.

Engineering Work at the State Agricultural Colleges and Experiment Stations. The primary responsibility of each one of the state agricultural experiment stations is to solve the problems of the agriculture of the state, or of that portion thereof which it represents. It would seem, therefore, that the project lists of these stations should be fairly indicative of the requirements of the agricultural practices of each state for engineering assistance. The work in progress at the agricultural colleges should also be of equal significance in this connection.

On the basis of the available records there were somewhere near 404 projects of research and investigation in agricultural engineering subjects in progress at those institutions on December 1, 1925. It is quite difficult to determine the exact number owing to the specific nature of some and the rather inclusive nature of others. This is especially true in the work on the use of electricity in agriculture. However, as far as can be determined, 23 of these projects deal with different phases of the general subject of land clearing; 30 with drainage; 80 with structures; 79 with machinery; 53 with power, including the use of electricity; 17 with water supply and sewage disposal; 75 with irrigation; 29 with materials of construction; 8 with soil erosion, and 10 with miscellaneous features.

These figures should perhaps be considered as relative rather than actual. This is due to the lack of uniformity in methods of reporting such work, and to the fact that frequently work in progress is reported which is not fully in project form. For convenience, however, all such work will be referred to as project work in the following discussion regardless of its status.

A search was also made of the entire project lists of experiment stations for work in agricultural engineering which is being conducted by divisions of agricultural science and not by agricultural engineering divisions. Such work was also included in the above figures.

Regardless of how one looks at this record of work, it is quite evident that a large and increasing amount of investigation is now under way in agricultural engineering. A growing need for broadly applicable fundamental research is also becoming quite apparent.

LAND CLEARING

The twenty-three land clearing projects on record are located at eight experiment stations. They deal with almost every conceivable method of removing stumps, brush, roots, and stones from land for the purpose of making it available for agricultural production.

The past record of this land clearing work indicates that no great amount of deeply scientific research has ever been engaged in. The progress results indicate that in most cases the work has been confined to the manipulation of available scientific and engineering principles. Apparently numerous local methods have been developed by such means which fully accomplish the desired results.

However, an analysis of progress results indicates that land clearing in all its stages is expensive. In many instances it is apparently too expensive to be wholly profitable. For this reason much of the recent work at the stations seems to have been aimed primarily at determining the relative economy of different methods of accomplishing the same operation. Apparently the progress in reducing the cost of the most efficient available methods has been painfully slow in many instances.

At least two big problems apparently exist in the subject which are of widespread importance. The first is how to reduce the cost of materials, labor, and power in the most

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efficient land clearing methods used at present. The second is how to salvage the by-products of land clearing so as to permit the process to partially or wholly pay for itself.

In connection with the first problem explosives and blasting methods, for instance, might well be studied by interested stations and generally standardized with economy in view. A concerted effort to secure a fundamental and standardized knowledge of the influence on blasting and other clearing methods of environmental conditions such as soils, type, size, condition, and weight of stumps, breaking strength of roots, etc., might also be worthy of consideration. The fact that some experiment stations are now considering features such as this indicates the feasibility of such a procedure. The land clearing work in some European countries especially is taking this more fundamental trend in an effort to secure greater economy.

In connection with the second problem the opportunity for the development of profitable methods of salvaging of land clearing by-products seems evident. One station, for instance, is attempting to salvage by-product stone and fuel, and the work at another station on the destructive distillation of pine stumps and the recovery of oils and spirits is especially noteworthy. A concerted effort to further develop and standardize such methods seems worthy of consideration by interested stations.

MACHINERY

The seventy-nine machinery projects on record are located at twenty-nine experiment stations. It is also known that at least two and possibly more land-grant colleges are conducting studies of farm machinery independently of any agricultural experiment station. Certain engineering experiment stations in land-grant institutions are also dealing with the subject.

Some of the machinery projects at the stations deal with the evolution of the principles governing new methods and machines to perform operations previously done inefficiently or not at all. Others deal with the further development and perfection of methods and machines, which actually perform certain operations, with the idea of increasing their efficiency. The greater part of this work seems at present to be second phase or local research. Much of it has, however, reached the point at which a certain amount of first phase research is necessary to its further progress.

Tillage Machinery. Tillage is one of the greatest power consuming operations in crop production. As a consequence, the experiment stations have been studying the factors governing the power requirement of tillage in an attempt to reduce it. There are now some fourteen such projects at eleven different stations.

Most of these studies have taken the form of draft tests of plows and cultivating tools under different soil conditions. The results have, however, been only very generally indicative. In fact, apparently little information has been obtained from simple draft tests upon which any marked changes or improvements in the design of plows and cultivating implements could be based with any great degree of precision or safety.

These and other tests have indicated, however, that the production of a desired degree of soil tilth by any tool, regardless of its shape, size, or speed of operation, is governed largely by certain soil properties and certain physical laws. Apparently, therefore, the work cannot advance much further until a knowledge of these fundamental factors is obtained. It seems necessary to (1) perfect methods for measuring and specifically designating degrees of tilth in soils corresponding to the optimum required by different crops, (2) elucidate and evaluate the properties of soils which govern the existence or production of such desired states of tilth, and (3) evolve and develop the physical and mechanical principles governing the design of tillage implements which will specifically meet the conditions imposed by the engineering properties of soils and will produce desired states of tilth.

The first two of these features are obviously matters of national importance and application, and may be classed under the general heading of soil dynamics. The fundamental principles involved in the third feature are also nationally as well as locally applicable and therefore also involve research of the first phase.

At least two experiment stations have gone into these widely important problems rather extensively. By the use of pure physical science one station has established some of the fundamental laws governing the frictional phenomena occurring between the surface of a tillage tool and the soil during the tillage operation. Thus one of the main causes for the power requirement of tillage has been elucidated. Certain important mechanical principles of plow design and operation have been deduced which should reduce the power requirement of tillage under certain conditions. Furthermore, the work has suggested certain fundamental physical principles of plow design which, if confirmed, should reduce the frictional resistance of plowing to a minimum under any conditions.

However, this work has dealt with only one factor in soil dynamics. The subject of soil dynamics as it influences tillage and the design of tillage machinery includes a number of factors. Each one of these factors must be elucidated and definitely evaluated in terms of its specific influence on the design of tillage machinery capable of doing certain definite things in soils. Soil dynamics therefore presents a national problem calling for concerted action by all interested stations in its complete fundamental solution with reference to tillage.

Traction Machinery. Another machinery problem of broad significance is that relating to the development of traction machinery for use in farm operations. Tractors, for instance, have been used on farms for several years. However, the conditions imposed by tractor farming operations have been found to be extremely severe in many cases. Since an intimate scientific knowledge of these conditions has not always been available, it has frequently been impossible to design tractors to meet them. Depreciation has consequently been quite high in such cases. There are now some nineteen projects at eleven different experiment stations which are concerned with the better adaptation of tractors to the severe conditions of farming with mechanical power.

The work in progress for several years on air cleaners is quite significant. Here is a problem of national importance involving a most intimate study of fundamental physics as applied to the design of tractor engines and their accessories. The proper lubrication of tractor engines to meet the conditions of tractor farming is another national problem. In fact, a knowledge of the exact wearing effects of all the conditions encountered in tractor farming on the moving parts of tractor engines, and of developing economical as well as satisfactory methods for guarding against them seems nationally important.

Experience has also demonstrated that many tractors, as at present designed, are inefficient for farm use, since they are mechanically incapable of meeting the traction conditions of agricultural soils. It has been comparatively simple to determine the slippage of tractor wheels in different soils and to establish the relative efficiencies of different types of available wheel equipment in this respect under definite local conditions. It has been found, however, that the tractive efficiency of a tractor is influenced by its total weight, distribution of its weight, and the power of its engine, as well as by its drivewheel equipment. In addition it has been determined that the principles of traction in soils are rather definitely related to their engineering properties and the manner in which stresses are distributed in and resisted by them. Therefore, the national importance of knowing more of the fundamental principles governing the traction of wheel tractors in soils to provide a universally applicable basis for the economical design of efficient tractors with reference to weight, power, and drivewheel equipment has become quite evident.

Other Machinery. There are numerous other projects on field machinery and on stationary belt-driven machinery, all of which seem to involve not only local problems but problems of national importance. The fact that half a dozen stations are dissatisfied with existing methods and machines for silage cutting and blowing, for instance, would seem to indicate that difficulties of considerably more than local importance relating to this equipment must be solved before its rational development for local purposes can proceed. It seems desirable that

efforts be made to determine the exact nature of these difficulties and to undertake their fundamental solution.

STRUCTURES

The seventy projects in structures on record are at thirty different agricultural colleges and experiment stations. These deal with numerous different features of the housing of farm stock and poultry and with the storage of crops, fruit, and vegetables.

Poultry Houses. Of these projects twenty-one deal with poultry houses. The fact that so many stations find local problems in the poultry house situation would seem to indicate the existence of problems of wide interest. For example, there is an apparent lack of exact knowledge of the air, temperature and humidity requirements of different breeds of poultry corresponding to optimum health, economy and egg production. No fully adequate basis seems therefore to be available for the proper design of poultry houses.

Here is a big national problem, yet so far apparently only one station has approached it on a comprehensive fundamental scale. It is so complex and its scope is so great that a broadly cooperative effort by a large number of interested stations to elucidate all of its features seems justified.

Livestock Shelters. There are fifteen projects dealing with livestock shelters including beef cattle and dairy barns and hog houses. The majority of these involve a ventilation and heating problem, and their widespread nature indicates the national importance of this problem. The information as to the exact requirements of different kinds of livestock with reference to optimum conditions of air purity, temperature and humidity is incomplete. An accurate and generally applicable basis for the design of structures for the proper housing of such animals is therefore not yet available in spite of an extensive knowledge of the insulating properties of different structural materials and of the physics of air movement under different conditions of temperature and humidity. The complexity of this problem seems fully as great as that relating to poultry houses. Here indeed is a widely important problem calling for an almost national cooperation of the experiment stations in the fundamental elucidation of its many features.

Crop and Fruit Storage. There are seventeen projects on the storage of crops, including fruit, vegetables and field crops.

The proper storage of crops seems to present a problem of widespread importance. Much work has been done in the past on the subject largely by specialists in branches of agricultural science. Agricultural engineers are now confronted by the great problem of devising economical storage structures which will provide temperature and humidity conditions permitting proper curing and preventing spoiling of crops. These conditions must be fully known for different crops before they can be provided in the storage structures by engineering manipulation. The broad scope of this work is evident when the extent of crops which must be stored is considered.

Structural Economy. The main purpose of the majority of these structures projects is to introduce economy into animal, poultry and crop production. However, there seems to be a further opportunity to introduce economy into the structures themselves. Several projects are on record, the purpose of which is to develop more economical designs of framing for farm structures and more economical types of structure in general. The national importance of knowing the specific strength requirements of the important members of farm structures to provide a sound basis for the most economical as well as satisfactory design seems obvious.

POWER

The majority of the fifty-three power projects on record are included in the activities at twenty-two agricultural colleges and experiment stations on the application of electricity to agriculture. It is to be noted in this connection that the Committee on the Relation of Electricity to Agriculture reports only seventeen general state projects. This would seem to indicate that not all the experiment stations doing work on the subject are connected with organized state projects.

Somewhat over a year ago a report, prepared by the Office of Experiment Stations, was published in AGRICULTURAL ENGINEERING (Vol. 5, Nos. 8 and 9—August and September, 1924), drawing attention to the broad general opportunities for research in the subject. Since that time the project lists of the stations have included an increasing number of projects dealing with different specific features of the subject mentioned in that report.

There is much evidence to indicate the national importance of the general subject of the application of electricity to agriculture. In addition the country is well supplied with manufacturers of electrical equipment. However, there seems to be a lack of specifications for electrical equipment which will economically as well as satisfactorily meet the requirements of agricultural practices and operations. For instance, the electric refrigerator and toaster are two pieces of equipment which have frequently been found unsatisfactory in farm homes.

In addition some of the experiment stations have found that work on electrical refrigeration, on the use of electricity in dairying and poultry husbandry, and on the use of electricity for operating different belt-driven machines, for instance, could not proceed much beyond the general stage until the methods and machines themselves were fundamentally perfect.

It is easy to say that refrigeration, for instance, consists merely of making things cold by established processes. But since economy is now of paramount importance in agricultural production, it is necessary first to learn rather accurately what temperature conditions are to be produced and how long they shall be maintained for certain farm commodities. It is then necessary to lay down rather definite specifications for equipment which can accomplish these things satisfactorily and economically to aid manufacturers in producing exactly what is needed.

The same general rule seems to apply to all other uses of electricity in agriculture. A host of nationally important problems is thus closely tied in with this movement.

Economy of Power. Among the power projects are several which deal with the power and labor factors involved in the production of certain important crops and how they may be reduced to a minimum by engineering manipulation. These are classified as power projects because the requirement advanced by the branches of scientific agriculture involved has indicated that power, whether man, horse, or mechanical, is the biggest item involved in the total cost of production of these crops. When this item represents as much as from 50 to 65 per cent of the total cost of the production of the national corn crop, for instance, it seems quite evident that something should be done.

The widespread importance of such work seems evident, especially when it is considered that the cost of production of national food and clothing crops such as corn, wheat, potatoes, and cotton are especially affected. The results of such investigation should indicate specifically what research should be undertaken, where it should begin, and what should be its scope. In fact, it is from such preliminary investigations that nationally important research projects, such as those on soil dynamics, tillage and traction mechanics, lubrication, ventilation, etc., originate. A cooperative study by interested stations of the power required in the production of nationally important food and clothing crops should bring to light the broadly important fundamental problems of common interest, which must be solved before economy can be introduced into production locally.

DRAINAGE

The thirty drainage projects on record are located at fourteen agricultural colleges and experiment stations. In addition it is known that several engineering experiment stations are dealing with drainage, especially in connection with the hydraulics and structural features of drains. Several foreign research institutions are also interested in different phases of drainage. The drainage work at the experiment stations is broadly divided between the drainage of soils of the humid regions and of irrigated soils and between the hydraulic and structural features of drains.

Drainage Hydraulics. With a very few outstanding exceptions there is little to indicate that serious attempts to get at the fundamental hydraulic principles of soil drainage be-

yond those applicable to the drains themselves are being made. It is true that several stations are investigating the influence of size, depth and spacing of drains on run-off and depth to the ground water level. Such work is, however, mainly of local significance and makes little or no provision for meeting a possible change in conditions.

Underground drainage is becoming a national practice, yet the design of drains so far as the movement of soil water is concerned is apparently based largely on tradition and an exercise of judgment. The extreme complexity and broad scope of the problem of soil hydraulics have probably been the main factors preventing any individual station from undertaking its solution on a comprehensive scale.

Several of the experiment stations are investigating certain features of the movement of water in soils from the agronomic viewpoint, and such work is undoubtedly throwing some light on the general subject. However, there seems to be a need for the establishment of broad, general hydraulic principles governing the movement of water in soil which, with proper modification to meet the established requirements of local soils and crops, can be used as a basis for the design of local drainage systems for both humid and arid conditions. A nationally cooperative effort in this direction by interested stations might be worth considering.

Drainage Structures. Economic studies of the life of underground drains conducted both in this country and abroad have apparently indicated the wide importance of investigating the strength and durability of structural materials used in drains, and their structural design. The cooperative work which has been conducted on the causes of the failures of agricultural drain tile, for instance, is a type of investigation which is important wherever underground drainage is practiced. It would seem that a more concerted movement along this line might tend to introduce greater economy in the national practice of soil drainage.

IRRIGATION

The seventy-five projects listed on different problems in irrigation are located at twelve experiment stations in arid or semi-arid states and at five experiment stations in humid states. With the exception of that on the irrigation of rice, the work in the humid sections is confined to the overhead irrigation of truck crops. The arid and semi-arid state work consists of numerous different features of the surface application of water to crops, including the design of the structures required for the conveyance, measurement, and distribution of irrigation water.

Much rather high-grade research is in progress in the irrigation field. The subject is an old one in the stations of irrigated arid and semi-arid states, and there has been ample opportunity to place much of the work on a sound fundamental basis.

However, the continued need for a broadly applicable fundamental knowledge of certain features of the work is indicated by the recent action of several of the western stations in inaugurating a cooperative fundamental study of the economical application of irrigation water. On of the main features of this work is the problem of the movement of irrigation water through and its retention by soils. Other problems involved are those relating to evaporation and its prevention, the optimum water requirements of individual crops, and the influence of irrigation on the ability of soils to retain and supply water in optimum amounts to crops. Such problems are of importance to all irrigated states. It is encouraging to note that this is being recognized by the stations and that cooperative attempts to solve these widely important problems are being made.

SOIL EROSION

Soil erosion projects are listed at only seven experiment stations. It is known, however, that a considerably larger number of experiment stations and state agricultural colleges are interested in the subject. This would seem to indicate that the necessity for research in the subject is not being taken very seriously by some institutions.

Of course, there are certain broad general practices which may be used under a number of conditions with a certain measure of success. Much of the work now on record is mainly of local significance apparently for this reason. However, the results of such work indicate occasionally that methods for the prevention of erosion, which are apparently successful under one set of conditions, are not economically applicable under other conditions. Neither are they particularly susceptible of modification to make them applicable. It seems, therefore, that certain broadly applicable fundamental principles of soil erosion and its prevention are needed. For instance, something should be known of the factors governing the so-called washability of soils under any conditions, and of the influence which is exerted on soil washability by the chemical composition, colloid content, mechanical properties and slope of the soil. It is believed that an analysis of the soil erosion problem might bring several such widely important features to light.

MATERIALS OF CONSTRUCTION

The twenty-nine projects on materials of construction used in farm buildings and equipment are at fifteen agricultural colleges and experiment stations. Naturally in such a subject the work is much more extensive than this list indicates. Several engineering experiment stations especially are engaged in studies of materials of construction suitable for farm use. The majority of the projects listed deal with the strength and durability of materials. There seems to be a need for work, therefore, which will establish broad general specifications for such materials, based upon the requirements of agricultural structures.

Fence Posts. It is a significant fact that seventeen of these projects deal with the strength and durability of different kinds of fence posts. The progress results of much of this work indicate that it is confined largely to simple tests of available materials. Apparently little fundamental consideration has ever been given to the fact that a fence post is a structural timber which must meet certain strength requirements. Furthermore, it must be able to meet these requirements for a certain minimum period of time without failure, to permit its economical use.

Much information is now available on the durability of wooden posts of different kinds and on the efficiency and economy of various preservative treatments. Such information is also available for steel, iron, and reinforced concrete posts. It would seem that interested stations might well give cooperative consideration to the establishment of broadly applicable engineering specifications for posts of any practical material which will permit them to meet the strength and durability requirements of national farm fencing.

WATER SUPPLY, SEWAGE DISPOSAL AND SANITATION

There are seventeen projects on water supply and sewage disposal at sixteen agricultural colleges and experiment stations. This subject is also one in which several engineering experiment stations are now or have been interested in, owing to its wide importance. It seems that opportunities for work of broad significance also exist in this subject.

Sewage Disposal. Eight of the projects on record deal with sewage disposal. The progress results indicates that most of these consist of tests which are mainly of local significance. The most comprehensive work is perhaps that being conducted by two or three of the stations on the biochemistry of farm sewage disposal to provide a basis for the design of equipment.

This subject has been dealt with for years by different agencies. As yet, however, the knowledge of the general biochemistry of farm sewage is apparently inadequate to permit the design of disposal systems to meet fully different farm conditions satisfactorily and economically. This applies not only to household sewage, but to some extent to other types of sewage connected with the agricultural industry such as that from dairies.

It seems, therefore, that here is another problem of broad significance which justifies a certain amount of fundamental consideration by groups of interested stations. A knowledge of the different classes of conditions to be met, of the degree of purification of sewage required by each class of conditions, and of the physical, chemical and biological processes involved in the production of such degrees of purification in standard

types of farm sewage would seem to provide a broadly applicable as well as fundamental basis for the local development of the necessary equipment.

CONCLUSION

This brief consideration of some of the features of research in agricultural engineering at the state agricultural colleges and experiment stations seems to indicate that there is a well-defined need for some original fundamental research to establish certain broadly applicable agricultural engineering principles. Much of the work of a purely local character has apparently reached a point beyond which it cannot proceed without further fundamental knowledge. This seems to be true in some of the features of nearly every branch of agricultural engineering.

In nearly every case also the necessity for cooperation between agricultural engineers and specialists in agricultural science is evident. This seems largely due to the fact that the nature of the work of the agricultural engineer is governed largely by the requirement for engineering assistance advanced by the branch of agriculture concerned. As agriculture develops such requirements increase in number.

It does not seem necessary, therefore, to look for or to attempt to create new opportunities to do national research in agricultural engineering. Such opportunities apparently already exist in quite considerable number, and many are crying for consideration. It seems necessary only for the agricultural engineering division of each experiment station to take stock of the requirements of the agriculture of the state for engineering assistance and of the extent of the engineering knowledge available for meeting such requirements, to determine what its contribution should be to a program of national agricultural engineering research. Furthermore it would seem that such a program should be confined mainly to the specific needs of the individual states concerned.

Many of the nationally important problems in agricultural engineering are obviously of too great scope and complexity for complete consideration by individual stations. It would seem that systematic and intelligent group consideration of such problems by interested stations should make for the earlier production of useful results as well as for economy in the use of funds and facilities.

The Field of the American Society of Agricultural Engineers in Reclamation

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cured. It happens that these were listed by reason of the fact that at present modified loan values are used by the federal land bank on account of fairly well-defined adverse conditions over and above the extent of project debts which must be considered in all projects where such debt constitutes a tax lien.

The government reclamation projects are not considered failures in this grouping notwithstanding some eastern authorities, though some adverse conditions exist and have caused their listing. Other projects have been listed which may now be in fair shape but which at some time past approached the near-failure state because of some fundamental difficulties. I would list eleven as complete failures at some time, of which six are failures now and four have since been resurrected in some form, with three successful and one hopeful, and one abandoned but the lands being successfully served by individual effort.

Five of the remaining projects may be classed as near failures. No loans are or would be made by the federal land bank. This leaves twenty-nine projects in which land values are not what they should be with all possible economic difficulties cleared up. In a number it is only a matter of increased water supply by storage, providing adequate drainage, or correcting faults which require time.

Most of the problems indicated under the heading "Lack of Economic Considerations" are those which in the future must in large part form the subject matter for agricultural engineering study and their solution form the basis of determining agricultural feasibility. From this it can be seen that the agricultural engineer or agriculturalist or the civil engineer specilizing in agricultural work must play perhaps the most important part in new reclamation development.

It follows from this that the field of the American Society of Agricultural Engineers, as stated by Major Stout, lies in the building up and making available of an organized body of knowledge covering the subject of agricultural feasibility of reclamation enterprises, covering the range of reclamation by irrigation, drainage, flood protection and salvage of cut-over lands. In addition, there is that wide field of facts and knowledge necessary to make the agricultural engineer of value in the individual farm and home development so often lacking in wise direction.

Engineering Aspects of Forestry

(Continued from page 52)

construction engineer and the architects are vitally interested in wood, whether for bridges, buildings, derricks, ties, or for any other purposes.

Finally, the forests are a most important landscape feature and trees are often the basis of landscape engineering. A landscape engineer who has a keen appreciation of the beauties of the natural forest can learn to use it to secure the finest aesthetic effects.

Forestry plays an intimate part in agricultural engineering. I need to mention only a few examples. Forest planting is one of the most potent means of fixing shifting sands which in many localities are a distinct menace to agricultural crops, as, for instance, on the Pacific Coast, and on the shores of the Great Lakes. A forest growth is the best binder of the soil, and in localities where gullies are a grave menace to farm lands, it is a tool which in the hand of a skilled engineer may become the means of stopping erosion and reclaiming eroded land to productive use. The forest as a windbreak for protecting buildings and crops against dry, hot winds in summer and cold blasts in winter and especially as a means of uniform distribution of snowfall, is a useful tool in the hands of the skillful engineer. Windbreaks in such states as North and South Dakota, by preventing the drifting of the snow into gullies and then distributing it more evenly over the fields, contribute to the useful work of the snow water in the spring. It is tatamount to increasing the precipitation in such states.

There are in the northern portions of the lake states, Michigan, Minnesota, and Wisconsin, vast areas of swamp lands. Some of these lands are just open bogs or muskegs. Others are covered with forest growth of rather inferior development. At present these areas are considered as waste land. A great deal has been said about draining the swamps for agricultural use. In some places the draining of such swamps, far in advance of agricultural needs, has proved a great burden upon the community. In the northern part of Europe, Finland, Scandinavia, and Russia, from vast areas of swamp forest lands the excess water has been removed by superficial ditching, and the timber growth increased from two to three times, making those lands profitable for timber growth.

The drainage for improvement of forest growth is not the same as drainage for agricultural purposes. It is a fairly cheap method. It does not involve bone-dry draining. It does not increase the fire menace in dry peat bogs. It does not destroy the habitat of wild life. On the contrary, by making the forest growth more vigorous and the cover denser, and by encouraging forest growth where no growth at all existed before, it increases the area for breeding and winter protection for many of our wild animals.

Engineers, and agricultural engineers in particular, have therfore a distinct field, an obligation to discharge, in the preservation and better utilization of the forest.

(Continued on page 66)

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Irrigation Studies at the Arizona Station, G. E. P. Smith, W. E. Code, and H. C. Schwalen (Arizona Station Report 1922, pp. 229-234, fig. 1).—Data are briefly summarized on ground water studies, stream flow measurements, pumping machinery, and other irrigation subjects.

Data on the effect of the transpiration of trees upon the ground water supply indicate a correlation between the transpiration losses in a cottonwood and mesquite forest and climatic factors, including temperature, humidity, and cloudiness, for different stages of leaf growth. The daily fluctuations of the water table caused by the transpiration of trees and by recharge of the water supply are large, sometimes exceeding 5 inches.

Tests of fuel oils for pumping are reported to have shown that, under the new process of cracking the crude oils now used by some refineries, the volatility of California cracked oil distillates is higher in relation to their specific gravities than that of straight run distillates. The cracked oils appear to have the same qualities as straight-run oils of 3 degrees Baume higher gravity.

Factors Influencing the Bacterial Flora of an Imhoff Tank, M. Hotchkiss (American Journal Public Health, 15 (1925), No. 8, pp. 702-704, figs. 2).—In a contribution from the New Jersey experiment stations studies on the fluctuations in bacterial flora in an Imhoff tank during an extended period of time and on the influence of changes in temperature on numerical changes are reported.

None of the results obtained suggested a relation with seasonal variations in temperature. It was found that the bacteria increase in the liquid of an operating tank and decrease during a resting period. It is suggested that there are various phases in the digestion of the material in the tanks in which a succession of bacteria takes a predominating part, and that variations in the manner of operating the tanks influence the general bacterial flora and tend to obscure any seasonal variations which may occur.

The Soil Mulch in the Absorption and Retention of Moisture, M. A. McCall (Journal Agricultural Research [U. S.], 30 (1925), No. 9, pp. 819-831, figs. 6).—Studies conducted at the Washington experiment station are reported, which showed that the soil mulch has an inhibitory effect on moisture absorption under conditions where individual rains are not of sufficient volume to penetrate the mulch fully.

The mulch inhibits absorption by increasing the amount of current evaporation in the newly fallen moisture. The volume weight of the stirred mulch being less than that of an equal depth of unstirred soil, the moisture content of the mulched soil immediately after a rain is higher on a percentage basis. When conditions favor evaporation a greater total loss from the mulched soil results. The final moisture content is due to a cumulative effect following several rains. The soil mulch prevents the loss of moisture already in the soil by checking evaporation.

The practical use of the soil mulch in moisture conservation is considered to be dependent on climatic conditions which influence the prominence of either the inhibitory effect on absorption or the positive effect on retention, or which may nullify either or both.

The Hexagonal Slab Design of Concrete Pavement, L. A. Perry (American Society Civil Engineers Proceedings, 51 (1925), No. 9, [pt. 3], pp. 1793-1808, figs. 11).—The results of experiments to determine what relation the shape of a pavement slab has on its strength are reported. With the records of these experiments, a study of moments, as developed in various shaped slabs, is also reported.

It is concluded to be incorrect to compensate for a pronounced weakness in design when that weakness may be eliminated. The right angle corner was found to be a pronounced weakness, and is therefore considered to have no rightful place in a concrete pavement except where it must occur along the outer edge. It was further found that harmful temperature cracks which intersect and form corners in an oversized slab may be avoided by a reasonable reduction of the slab area. The necessity of forming reasonably small slabs to avoid these cracks may be met without the formation of interior right angle corners.

It is believed that the economical design is a grouping of slab units of plain concrete, each unit sized so as to prohibit temperature cracks and excessive bending moments, and entirely independent of and disconnected from adjacent slabs, which prevents injury to any one slab by reason of the displacement or failure of its neighbor. It is believed further that each slab should be cast in the shape of a hexagon.

Permissible Canal Velocities, S. Fortier and F. C. Scobey (American Society Civil Engineers Proceedings, 51 (1925), No. 7, [pt. 3], pp. 1397-1413).—This paper, which is a contribution from the U. S. D. A. Bureau of Public Roads, constitutes the final report of the special committee on irrigation hydraulics of the American Society of Civil Engineers. The data presented show that the laws of hydraulics governing the movement of loose silt and detritus in open channels are only distantly related to the laws governing the scouring of a canal bed, and are not directly applicable.

The material of seasoned canal beds is composed of particles of different sizes, and when the interstices of the larger are filled by the smaller the mass becomes more dense, stable, and less subject to the erosive action of water. The velocity required to ravel and scour a well bedded canal in any material is much greater than the velocity required to maintain movement of particles of that same material before becoming bedded, or that have been raveled off by higher velocities than the bed would stand.

Colloids in either the material of the canal bed or the water conveyed by it, or in both, tend to cement particles of clay, silt, sand, and gravel in such a way as to resist erosive effects. The grading of material from fine to coarse, coupled with the adhesion between particles brought about by colloids, makes high mean velocities possible without any appreciable scouring effect.

It is concluded that irrigation canals may be designed for the velocity that is permissable when seasoned by age, as the demand for water grows with the age of the canal, and the maximum mean velocity grows with the supply necessary to satisfy this demand. Canals when new may be operated with velocities less than the maximum permissable by the use of check structures. A slight excess of velocity is considered preferable to insufficient velocity.

It is further concluded that the growth of aquatic plants is but partially connected with velocities, and that canals designed for the highest permissible velocities from the standpoint of erosion will be as free from plant growth as design alone can effect.

Heat of Wetting of Soils Dried at Different Temperatures and the Force at Which Soils Absorb Water, G. Bouyoucos (Soil Science, 20 (1925), No. 1, pp. 67-72).—Studies conducted at the Michigan experiment station to determine the heat of wetting of soils dried at different temperatures are reported.

Drying soils at 50, 75, 107, and 140 degrees Centigrade (122, 167, 226.6, and 284 degrees Fahrenheit) for 24 hours caused the heat of wetting to increase rapidly up to a temperature of 107 degrees and to reach its limit at about this temperature. The heat of wetting of soils dried at 107 degrees was from 293.7 to 1,084 per cent greater than that at the temperature of 50 degrees, the heat of wetting at 50 degrees being taken as 100 per cent.

The amount of moisture which is effective in producing the heat of wetting was found to be comparatively small, ranging from 1.4 to 12.1 per cent. Of this total effective moisture, only a very small part, driven off at 107 per cent, is responsible for the major portion of the heat of wetting. It was further found that if it were possible to add again to the dry soil only its effective moisture content which is responsible for its heat of wetting, the temperature rise would be enormous.

The force of absorption was found to range from 92,250 atmospheres in Rhode Island sandy loam to 124,300 atmospheres in Carrington clay loam, to 156,200 atmospheres in muck.

It was found that the soils must be dried at around 107 degrees for more than 10 hours in order that they may be dried thoroughly and thereby allow a truer estimation of their colloidal content. The data seem to indicate that a portion of the loss in weight when soils are heated much above 100 degrees represents a loss of organic and inorganic matter by volatilization.

Studies in the Physical Properties of Soils.—I, Mechanical Properties Concerned in Cultivation, W. B. Haines (Jour. Agr. Sci. [England], 15 (1925), No. 2, pp. 178-200, figs. 8).—In a contribution from the Rothamsted Experimental Station, the mechanical properties of soils which are concerned in plowing are considered under the three headings of cohesion, plasticity, and surface friction between soil and metal. In each case methods of measurement are discussed and experimental curves are given for representative soils over the whole moisture range with which the practical agriculturist is concerned. In the case of cohesion, Atterberg's method of measurement is followed. A new technique is described for measuring one of the plastic constants, which is specially adapted to clays, and throws fresh light on their physical characteristics. The measurements on soil friction are considered to open up a fresh subject, and promise to provide a sensitive means of investigating soil-water relationships from a new angle.

The cohesion studies showed that a general qualitative relationship apparently exists between the results of laboratory experiments on the cohesion of puddled soil and those of field measurements of cohesion. Laboratory tests of samples taken from certain plats on the same field which had shown marked differences in the dynamometer readings during plowing showed the same differences in the cohesion curves as were noted in the field. The values were comparable in a qualitative sense only, but the results are

considered to mark a definite step toward a specification in exact terms of the field characteristics of different soils.

The results of preliminary experiments on surface friction between metal and a light sandy soil and a heavy loam as they were gradualy dried showed that both soils gave a practically constant friction for a range of moisture content from 0 to about 12 per cent. At this point the soils began to wet the metal, and an increase in friction resulted. This increase reached a maximum at about 17 per cent moisture content in the light sandy soil. Beyond that point the metal surface was wetted so freely as to be lubricated by the water film, and the friction decreased. This continued until the soil was too fluid to bear the weight of the metal slider.

The heavy soil showed two maxima in the friction instead of only one. These corresponded to two different manners in which such a soil may be said to wet a metal surface, namely, wetting without sticking and sticking. In the one case the water in the larger capillaries in the soil wets the metal surface, but the soil itself is firm and coherent, so that the metal slides without being contaminated by the soil to an appreciable extent. For this soil, shrinkage measurements showed that the soil pores were just full of water at about 19 per cent, so that the wetting began a little before this stage was reached and extended considerably beyond it. Later, as in the case of the sandy soil, the wetting became so free as to produce a lubricating effect. The beginning of the second increase in the friction curve corresponded to the point at which the soil began to stick to the metal. This corresponded to a definite stage of water saturation of the clay in the soil, and true surface friction ceased at this stage, since the slippage took place no longer at the surface of contact but within the top layers of the soil itself. The governing factor was then the plasticity.

The moisture content of Rothamsted soil during plowing operations was usually about 20 per cent, which conditions did not approach the region of stickiness. On soils which were very heavy to plow, the moisture content was 28 per cent and the plowing draft was 40 per cent greater than on the immediately adjacent plat with 22 per cent moisture. These results are taken to indicate that over a moisture range suitable for plowing the cohesion increases when the friction decreases, and that the choice of an optimum moisture from the point of view of the ease of plowing should consider two opposite effects.

No consideration is given similar work which has been reported on from time to time by certain American experiment stations.

River Gauging, M. A. Hogan (London: [Great Britain] Dept. Sci. and Indus. Research, 1925, pp. VIII + 70, pls. 18, figs. 8).—A report is presented on methods and appliances for river gauging suitable for use in Great Britain. The use of the sharp edged weir without side contractions is suggested for gauging small streams. For larger rivers, under natural conditions of flow, the stage discharge curve should be used, current meters being used to measure the flow. The discharge of canalized rivers should be measured by calibrating a weir by a combination of model experiments and current meter measurements.

Tests of current meters are reported which showed that for low velocity the Price and Amsler meters give sufficiently good results down to a velocity of 0.5 feet per second, and the Stoppani meter gives satisfactory results at velocities of 0.75 feet per second and over. No serious difference was observed between the results obtained in large and small channels. The error caused by obliquity was found to be increased in a small channel, and it appeared that the Stoppani meter has a maximum error of only $\pm$ 5 per cent, due to oblique flow, while the error in an unsealed screw meter, such as the Amsler or Ott, may be as much as —25 per cent.

Other tests at low velocity showed that the records of a weight driven meter at various velocities are greatly influenced by the pitch of the blades. A pitch of 30 degrees seems to give the best results. The results for a given pitch were dependent on the value of the driving weight, which must be neither too large nor too small. With a suitable helix and weight the still water rating gave a curve which seems suitable for measuring purposes. In moving water the velocity given by the meter using the still water rating curve was too low at low velocities, and the individual observations showed large discrepancies.

Descriptions of three typical current meters are appended.

Colloidal Behavior of Soils and Soil Fertility.—I, Suction Force of Soils as an Index of Their Colloid Content, J. S. Joffe and H. C. McLean (Soil Sci., 20 (1925), No. 2, pp. 169-175, fig. 1).—Studies conducted at the New Jersey experiment stations are reported, in which the method of V. C. Kornev[1] for the study of the suction force of the soil is presented and analyzed.

The results indicated that the suction force of the soil, being an expression of the molecular and capillary forces, may be used as an index of the colloid content of the soil. The forces which govern the suction force are therefore to be looked for in the soil colloids, which by virtue of their surface energy, possess and exhibit the properties which produce this suction force. Variations in the suction force of like soils with a variable organic matter content seem to indicate the plausibility of using the expression of this force in determining the amount of organic colloids in soils.

The ratio of the suction force of any soil to the suction force of the isolated colloids of the same soil multiplied by one hundred may serve as a convenient index of the quantity of colloids present in the soil under the conditions and time of the experiment. There is an indication that the graphic presentation of data on the suction force of various soil types may serve as a means of establishing not only the quantitative relations of the colloids in the soil, but also many other points in connection with the colloidal behavior of soils.

[1]Zhur. Opytn. Agron. (Russ. Jour. Expt. Landw.), 22 (1921-23), No. 1, Orig., pp. 105-111.

Studies in Soil Cultivation, I-III, B. A. Keen and W. B. Haines (Journal Agricultural Science [England], 15 (1925), No. 3, pp. 375-406, pls. 2, figs. 10).—Three contributions to the subject from the Rothamsted Experimental Station are presented.

I. The evolution of a reliable dynamometer technique for use in soil cultivation experiments.—An account is given of a reliable technique that has been evolved for making dynamometer measurements in the field. It is shown that quite small variations in the trace of the drawbar pull are significant, and correspond to actual variations in the resistance of the soil. No significant change in drawbar pull is produced by imperfect adjustments in the hitch or set of the implement within the limits met with in ordinary plowing except in so far as the depth of working is affected. The drawbar pull bears a linear relationship to plowing depth within the limits of ordinary plowing. The slope of the land is without appreciable effect on the drawbar pull up to gradients of 1 in 40.

A detailed study of the effect of changes in speed showed that although the drawbar pull increases with speed, the percentage increase is relatively so slight that considerable saving in labor and other costs should result if the speed of plowing were increased. The ordinary expression for work done, the product of drawbar pull and distance, was found to be unsuitable as a measure of the power output, and pending direct determinations of fuel consumption, the so-called power factor, defined as the product of drawbar pull and the time taken to plow a unit of length, was employed.

The general conclusion is drawn that during a steady run with tractor and plow the variations in drawbar pull can be ascribed entirely to variations in soil texture or soil resistance, and that chance changes in the implemental factors will not produce large effects.

II. A test of soil uniformity by means of dynamometer and plow.—Measurements are recorded of the resistance of soil to plowing, taken with a view of testing the uniformity of a soil over a single field. The results indicate large variations over short distances, and the differences are presented by means of isodyne contours drawn on a map. The importance is emphasized of assuming and allowing for such variations before drawing conclusions from the drawbar pull recorded by different implements. Preliminary work is described, showing that the variations are correlated with clay content and also with the growth of a crop in its early stages.

III. Measurements on the Rothamsted classical plots by means of dynamometer and plow.—Maps showing the resistance of soil to plowing, drawn up from dynamometer readings taken over several seasons for the Rothamsted classical plats, carrying wheat, barley, and roots, are reported. The conclusions as to the effect of manurial treatment are of only a general nature, and such differences as are evident are small in comparison with the natural variations in the soil. In the case of the Broadbalk wheat plats the drawbar pull values had a close relationship with the clay content of the soil and with certain aspects of the soil drainage.

The Experimental Sullage Farm, Lyallpur, P. E. Lander (Agricultural Research Institute, Pusa, Bulletin 157 (1925), pp. 25, pls. 2, figs. 6).—The results of experiments being carried on at the experimental sullage farm at Lyallpur from the time of their commencement at the end of 1917 up to June, 1924, are presented. This farm owes its origin to the fact that the town sewerage system is situated so close to the Lyallpur Agricultural College as to constitute a nuisance. Experimental cultivation was therefore undertaken with sewage diluted with canal water. The present farm is not entirely satisfactory, its uneven fertility and small size tending to militate against the obtaining of as accurate results as are desirable.

It has been found, however, that the natural fluctuations in the total nitrogen content of the soil even over short periods of time are out of all proportion to the nitrogen which has been applied in the sullage water. The improved crop yields are therefore apparently not the result merely of an increased application of nitrogen over that contained in the canal water, but also depend on certain accessory factors which the sullage water furnishes and which may be possibly placed in the same category as the well known accessory food factors so important to animal life.

Wheat is apparently unsuited for treatment with sullage owing to its great tendency to lodge when growth is forced. The crops best suited for treatment with sullage have been found to be green fodders, vegetables, and sugar cane where a forced vegetative growth is required. Maize does very well and can occupy the ground from April to October, after which it can be followed by winter oats. This is apparently one of the best rotations for the use of sullage water.

Underground vegetables tend to crack and burst when grown on soil treated with sullage water except when in great dilution. This was particularly noticeable in carrots and turnips. On the other hand, vegetables such as cauliflower and spinach, the edible portion of which was above ground, were improved in both condition and yield by sullage water. Thick sugar cane has not so far done well on the farm.

The Action of Sulphate Water on Concrete, D. G. Miller (U. S. Department Agriculture, Public Roads, 6 (1925), No. 8, pp. 174-179, 183, figs. 4).—In a further contribution to the subject (Agr. Engin. 5 (1924), No. 5, p. 209), a summary of tests made by the University of Minnesota, the Minnesota State Department of Drainage and Waters, and the Bureau of Public Roads, of specimens of concrete

immersed for one year in Medicine Lake, South Dakota, are reported. The specimens used were 2 by 4-inch cylinders, the majority of concrete, but a number also of Ottawa sand mortar. The total salt content of Medicine Lake was found to range between 2.34 and 4.72 per cent, consisting almost entirely of a combination of magnesium and sodium sulphates in which the magnesium salt greatly predominated.

None of the high-alumina cement cylinders showed evidence of any deleterious action. None of the standard Portland cement cylinders cured in steam at a temperature of 212 degrees Fahrenheit, regardless of the length of time they were so cured or of other variables, showed any surface action from the lake water.

Curing in water vapor at temperatures of 155 and 100 degrees was found to be of no value. Considerable deterioration was evident in all cylinders cured in the laboratory in the moist closet, followed either by further curing in water or by storing in air, or both.

Under some conditions additions of blast furnace slag, calcium chloride, Cal, and ironite increased the resistance of the concrete, while additions of volcanic ash and Alkagel "A" were of little or no benefit.

Charts for the Establishment of a Rational Tariff in the Distribution of Rural Electricity [trans. title], M. Pelou and E. Lajoue (Rev. Gen. Elect., 17 (1925), No. 12, pp. 450-460, figs. 3; abs. in Sci. Abs., Sect. B—Elect. Engin., 28 (1925), No. 332, pp. 387, 388).—Having indicated the necessity of determining a selling price which will take into account the different elements concerned in rural electricity supply, the authors present charts for the graphical solution of the problem.

On the assumption that the capital charges on a rural line must be covered by the local authorities, or by other special arrangements, if the service is to be economically possible, the selling price P_r per kilowatt hour at the consumer's terminals is determined. This price is calculated from $P_r=(P_a/p) + wt/W$, in which P_a equals the purchase price per kilowatt hour, high tension, p the efficiency of distribution, w the first cost of installation per inhabitant, t the maintenance factor, ranging from 0.015 for lines on reinforced concrete standards to 0.05 for lines on plain wooden poles, and W equals the total annual consumption in kilowatt hours per inhabitant. This equation, containing five variables, is solved by the aid of a chart of the quadrant type, i. e., four distinct sets of curves so arranged that two have the same scale of abscissae and two have the same scale of ordinates. The method of construction is fully explained.

Actual charts are presented for calculating the selling price per kilowatt hour at the consumer's terminals, for determining the efficiency of a network, and for determining the mean power factor of a network. Numerical examples are given in each case. The same type of chart can be applied to the solution of many other problems.

The Dispersion of Soil in Water Under Various Conditions, A. N. Puri and B. A. Keen (Jour. Agr. Sci. [England], 15 (1925), No. 2, pp. 147-161, figs. 7).—Studies conducted at the Rothamsted Experimental Station of the intensity of the forces binding soil particles together when the soil has been previously subjected to treatments simulating varying field conditions are reported. The technique adopted consisted in shaking soil with water under reproducible conditions, allowing the mixture to stand for 24 hours, and then determining the concentration of soil in the top 8.5 centimeter of the suspension. This concentration was expressed as a percentage of the original concentration of the soil, and the value thus obtained was called the dispersion factor of the soil under the given conditions of the treatment.

It was found that disintergration of soil aggregates by shaking in water proceeds continuously, rapidly at first and then more slowly. After nearly 100 hours of shaking, the dispersion factor is still slowly increasing, and its change with time after the first rapid increase is completed can be expressed by the equation $d=a+K \log t$, in which d equals the dispersion factor, t the time of shaking, and a and K are constants.

The dispersion factor was found to depend on the original concentration of the soil. There were slight but systematic changes in the lower concentrations, and when a certain maximum concentration was passed flocculation occurred. It is considered probable that in addition to the increase in concentration the concomitant increase in the amount of soluble salts present is concerned in the flocculation process. The dispersion factor for clay decreased continuously with decrease in initial moisture content, whereas with soil a stationary value was reached when the moisture content was reduced to a certain value. Contact with water or water vapor broke up soil aggregates only very slowly.

A progressive decrease in the dispersion factor was caused by heating the soil to temperatures over 110 degrees Centigrade (230 degrees Fahrenheit), but up to this temperature no reduction appeared. In the case of clay, heating to 100 degrees greatly reduced the dispersion factor. The influence of electrolytes was progressive and gradual and not a sharp flocculation or deflocculation. With good deflocculants as the concentration was increased, the dispersion factor increased to a maximum, decreased slowly, and then rapidly until complete flocculation occurred.

A comparison of various methods recommended for soil dispersion showed that the use of a rubber pestle is one of the most efficient.

Depreciation of Farm Machinery

(Continued from page 50)

The other miscellaneous items were new sprockets, arms and forks.

A study of the machines that have tongues shows that the following percentages requiring replacement of broken tongues:

147 corn planters	5.4 per cent
226 cultivators	13.7 per cent
119 mowers	14.3 per cent
122 wagons	18.8 per cent
103 manure spreaders	12.6 per cent

This factor suggests the following remedies: Better care of the tongue by coating with a wood preservative (Many farmers complained that the tongue rotted or became defective at the point where it joins the frame); a more rigid inspection by the manufacturers of the material from which tongues are made; replacing the wooden tongue with a properly designed steel tongue.

The mortality curve and probability curve accompanying this paper is based upon the same principles as the mortality tables and curves of insurance companies. Since these tables and curves have been found to be of practical value in conducting the insurance business, it, therefore, seems logical that similar curves and tables relative to farm implements would be of value to the farm implement industry. However, no claims are made for the curves, as perhaps it would be more desirable to have a larger number of machines which undoubtedly make it possible to locate the points on the curve more accurately. The curve is intended primarily to show how much data could be applied, and, in a general way, it does show the application of the above-mentioned principles as applied to grain binders. The following information may be determined by the use of such curves and tables:

1. The percentage of machines that survive at any particular age.
2. The number of years of future service that may be reasonably expected from a machine at any given age.
3. The value of a machine at any given age is equal to the cost when multiplied by expectancy divided by the probable life.

Engineering Aspects of Forestry

(Continued from page 63)

The remarks by Mortimer E. Cooley, dean of engineering at the University of Michigan and a past-president of American Engineering Council, express this thought much better than I could possibly do. In a letter to President Hartness of the American Engineering Council, he says:

"It has been one of my ambitions to do something worth while in reforestation. I consider it the most vital factor in the future welfare of the country. Looking into the future no further than 75 to 100 years I can see conditions arising, if our cut-over lands remain barren, which will make it very difficult if not impossible to live in this north temperate zone of ours, certainly not in the way we are now living. The price of coal will have advanced beyond what the ordinary man can pay; and the streams which can produce 50 millions of horsepower will have become filled with earth and silt washed from the watershed to such an extent as to partially or wholly destroy them for power purposes. . . . . And he (the engineer) could do so much if he would. And he will, I am sure, when finally aroused to a sense of his responsibility. I have faith in the engineer—absolute faith—that when aroused he will see the way, dark as it is, to bring to bear a protective hand as great as his creative hand is now. If the engineer and all the name implies fail the world, what must the writiings of the future be for ours, the greatest of all civilizations we know aught of?"

A. S. A. E. and Allied Activities

The Annual Meeting

ELABORATE preparations are under way for the twentieth annual meeting of the American Society of Agricultural Engineers, to be held at Lake Tahoe, California, June 23, 24, 25, and 26, 1926. A report made by Dr. E. A. White, past president of the Society, at present on a trip to the Pacific Coast states that he was most surprised and gratified to find plans for the meeting so well advanced at such an early date. If the present plans carry through the 1926 meeting will not only eclipse past efforts but come near to approaching the ideal which officers of the Society have held in regard to the annual meeting.

Forty Californians are at work on various phases of local arrangements. The meeting is already advertised from one end of the state to the other. Prospects for a large local attendance are good. Nothing will be left undone to provide for the entertainment and comfort of those attending from other parts of the country. Hotel accommodations, camping facilities, road maps, boat rides, field trips, special train from Chicago, are all being provided for. In addition a most interesting and worthwhile program is being arranged by the Meetings Committee.

The National Farm Homes Conference

THE program for the National Farm Homes Conference to be held at Hotel Sherman, Chicago, Illinois, February 18 and 19, 1926, is practically complete. This conference is being sponsored by the American Society of Agricultural Engineers, through the Farm Structures Division, with the cooperation of a large number of national organizations. A great deal of interest and enthusiasm has been mainifested in this conference and a large attendance is anticipated.

The first day's session will be opened by a statement of the purpose of the conference by Deane G. Carter, professor of agricultural engineering at the University of Arkansas and chairman of the Farm Structures Division of the Society. Prof. Carter will preside as chairman of the conference. Other features of the morning session will include an address, entitled "The Agricultural Engineer and the Farm Home," by F. A. Wirt, president of this Society, and a paper on the subject "An Analysis of Farm Home Needs," by William Draper Brinckloe, farmer-architect of Easton, Maryland.

During the afternoon session of the first day arrangements are being made with Radio Station WLS to broadcast a part of that program. The features of this session include a paper entitled "Planning the Farm Home," by K. J. T. Ekblaw, consulting agricultural engineer, Chicago. A paper entitled "Improving the Farm Home," by Mrs. Ellen Rose Dickey of the Sears-Roebuck Agricultural Foundation, and a paper entitled "What We Farm Women Want Our Homes to Be," by Mrs. H. M. Dunlap, of Savoy, Illinois. Mrs. Dunlap has spent several years making a very careful study of ways and means of saving labor and adding to the comforts and conveniences in her own farm home.

An informal dinner will constitute the evening session of February 18. In connection with this dinner arrangements have been made to broadcast the program by Radio Station WLS. An interesting and important feature of this session will be an address entitled "Evolution of the Farm Home," by Dr. Louise Stanley, chief of the bureau of home economics of the U. S. Department of Agriculture.

The morning session of February 19 will be devoted to reports of official representatives of national organizations interested in the better farm homes movement and include such organizations as the American Farm Bureau Federation, National Grange of the Patrons of Husbandry, General Federation of Women's Clubs, Better Homes in America, Bureau of Home Economics of the U. S. Department of Agriculture, U. S. D. A. Division of Agricultural Engineering, and the Division of Building and Housing of the U. S. Department of Commerce. These reports will be followed by a general discussion.

The afternoon session of February 19 will be devoted to a general discussion of ways and means of improving farm homes with a view to formulating a definite program of activity along these lines. The purpose of the National Farm Homes Conference is to bring, through discussion and awakening of interest, the pressing needs of the farm home to the attention of the best authorities in the architectural, home economics and household engineering fields that a broad, progressive, and coordinated program of farm home betterment may be developed.

A Cooperative Tractor Meeting

FOLLOWING the plan inaugurated a year ago, the American Society of Agricultural Engineers and the Society of Automotive Engineers will again hold a cooperative meeting in Chicago this spring. The dates of this meeting have been set for March 25 and 26, 1926.

The Society of Automotive Engineers will have charge of the first day's program. Tentative plans for the S.A.E. program provide for a session on engineering and production and a session on application and operation. The topics that have been tentatively selected for these two sessions include manifolding and carburetion of low-grade fuels, the production of tractors, the status with regard to tractors with small high-compression engines, tractor research, industrial application of tractors, and tractors in road building and maintenance.

The Farm Power and Machinery Division of the American Society of Agricultural Engineers will be responsible for the program of the second day, February 26. The tentative schedule of papers for this program includes the subjects which follow: Friction clutches, lubrication of tractors, tractor design as influenced by probable future agricultural requirements, and safety and personal comfort of the tractor operator.

This program is of vital interest to engineers and others interested and engaged in all phases of tractor development, design, application, and research.

American Engineering Standards Committee

DEVELOPMENT IN INDUSTRIAL STANDARDIZATION

THE year 1925 showed important developments in the growth of the industrial standardization movement. One of the most important of these has been the increase of of active interest on the part of industrial executives. Formerly, the matter of standardization has been left largely to the technical man, but it is now generally recognized that standardization is a managerial problem of the first rank.

Of special interest to the factory owner and manager is the Directory of Specifications, published in August, 1925, by the Department of Commerce. This compilation lists approximately 27,000 existing specifications covering 6,000 commodities, and it will be found very useful in connection with purchases.

The work of the American Engineering Standards Committee is typical of the standardization movement as a whole, since the Committee acts as a general clearing house, and each project promulgated under its auspices represents the combined effort of many trade, technical and governmental organizations. The list of projects now before it, at various stages of development, totals 218, including 76 approved

standards. Notable progress has been made during 1925 in the completion or further development of many of these projects. The number of projects of each industry represented in this work, through 250 national organizations, is as follows: Civil engineering and the building trades, 35; mechanical engineering, 63; electrical engineering, 32; automotive (automobile and aircraft), 4; transportation, 9; ship-building, 1; ferrous metallurgy, 9; non-ferrous metallurgy, 15; chemical industry, 12; textile industry, 3; mining, 16; wood industry, 5; pulp and paper industry, 1; miscellaneous, 13.

In the field of mechanical engineering, a system of limit gaging, together with a comprehensive scheme of fits, which is probably the most important project ever carried through by the American Engineering Standards Committee, lays the basis for the carrying out of complete interchangeable manufacture on a national scale, as well as for facilitating mass production within the individual factory. When this work permeates the structure of American manufacturing industry, the resulting savings will run into enormous figures. Two important dimensional standards, dealing with cold-finished shafting, and square and flat shafting keys, have also been approved.

In the electrical field, the 1925 edition of the National Electrical Code, the bible of the electrical wiring industry, has been approved. Also a system of connections and markings for electric power apparatus, representing the combined effort of a large number of engineers, has been approved as American Standard, after standing the test of several years practical application on a large scale.

For the first time complete national agreement has been reached on a safety code for aeronautics, in the development of which the military and civil branches of the federal government and the commercial and public agencies interested in the subject were represented. The code deals with standards of safety for design, construction, testing and operation of aircraft.

The mining industry is the most recent of the great industries to take up standardization on a comprehensive scale. The leaders in the movement have been the U. S. Bureau of Mines and the American Mining Congress. In addition to the sixteen standardization projects now under way, under the procedure of the A.E.S.C., three more have been officially proposed. A notable step in the prevention of mine explosives has been the completion of a code for rock dusting of coal mines, through the cooperative effort of all interested groups.

In the field of industrial safety, satisfactory progress has been made on a program of some forty codes, most of which are applicable to factories.

The fourth year of the work of Mr. Hoover's Division of Simplified Practice has shown even more rapid development than heretofore. In all, 39 simplifications have already been carried through, 10 others are in the final stages, and 65 additional surveys are now under way. Over two hundred industrial groups are cooperating in the various projects.

Approximately 350 specifications have been promulgated by the Federal Specifications Board, which means that these specifications have been unified as between the various branches of the government.

With some important exceptions, manufacturers generally have carried on their standardization work as a more or less incidental part of their engineering and production activities. But thorough-going standardization simplifies and clarifies every step in the work of the manufacture from the solicitation of the order to the mailing of the receipted bill. Definite organizatior for standardization work within companies has thus become a pressing managerial problem.

Another special problem on which marked progress should be made during the coming year is to get organizations of distributors to play their proper role in the standardization movement. It is generally recognized that the most important industrial and economic wastes are in the field of distribution, and that broad programs of standardization are essential to the elimination of this waste. Mr. Hoover, for example, rates standardization as second only to statistics in its importance in the whole distribution problem.

UNIFICATION OF WIRE AND SHEET METAL GAGES PROPOSED

THE American Engineering Standards Committee has been requested by the Society of Automotive Engineers to take up the unification of wire and sheet metal gage systems in order to arrive at a national standard system of designating the diameters of metal wires and the thicknesses of metal sheets. The systems of gage numbers by which these products are generally designated at present have been developed and adopted in the course of time in different trades and for different products, as steel and copper wire, aluminum, brass and zinc sheets, etc. In the request submitted by the Society of Automotive Engineers there are listed 13 gage systems now in use in this country. This wide diversity necessarily leads to confusion. Errors frequently occur in the filling of orders and in industrial work in general. Some organizations, in order to avoid confusion, have entirely done away with gage numbers and designate wire and sheet metal sizes exclusively in decimal fractions of an inch.

A conference of all industrial groups interested in this problem will be called in the near future to discuss the desirability and possibility of unifying the various existing gage systems into a consistent national system, or systems.

A question which is closely connected with that of the designation of wires and metal sheets is whether or not it is feasible to thin out the series of diameters or thicknesses actually listed in the catalogues of the different trades. Inasmuch as a procedure of this nature involves the element of "simplification," the American Engineering Standards Committee and the Division of Simplified Practice of the Department of Commerce have made arrangements to cooperate actively in this matter. The latter body will undertake to bring about production surveys in the trade concerned, in order to find out the relative importance of wires and sheets made to the several gage numbers.

CAN AMERICAN AND BRITISH SCREW THREADS BE UNIFIED?

THE American Engineering Standards Committee and the National Screw Thread Commission have invited the British Engineering Standards Association to a conference to consider the possibility of unifying the American and British screw thread systems.

Both the American and the British systems of screw threads have been the result of a long national development, the basis for the American system having been laid by William Sellers in 1864, and that for the British system by Joseph Whitworth in 1841. The standard threads are called "American (national) standard thread" in this country, and "British Standard Whitworth (BSW) thread" in Great Britain. Insofar as the number of threads per inch for the various diameters are concerned, the two national systems correspond to a large extent.

A fundamental difference between the two national systems exists, however, with regard to the angle of thread. This angle is 60 degrees for the American, and 55 degrees for the British thread. Another difference, of less importance, consists in the American thread having flattened crests and roots, whereas those of the British Whitworth thread are rounded.

New A.S.A.E Members

A. H. Bates, superintendent of tractor department and works engineer, Emerson-Brantingham Co., Rockford, Illinois.

A. R. Beal, sales promotion manager, Central Hudson System of Gas and Electric Companies, Poughkeepsie, New York.

H. Beningfield, managing engineer, Cletrac (South Africa) Ltd., Durban, South Africa.

Wilbur Fisk Crane, Palmyra, New Jersey.

William J. Fox, superintendent of Mohawk Division, Fulton County Gas & Electric Company, Cobleskill, New York.

Howard C. Miller, agricultural engineer, Utica Gas & Electric Co., Utica, New York.

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Thomas D. Harman, general manager, Stockman-Farmer Publishing Company, Pittsburgh, Pennsylvania.

Fred S. Hoefer, power engineer, New York State Gas and Electric Corporation, Oneonta, New York.

O. W. Johnson, president, Ward-Love Pump Corporation, Rockford, Illinois.

R. B. Lourie, vice-president, John Deere Plow Works, Moline, Illinois.

W. C. McWhinney, general business agent, Southern California Edison Company, Los Angeles, California.

James M. Miller, Jr., ranch manager, J. Mills Orchard Corporation, Hamilton, California.

Wilbur K. Moffett, manager of agricultural bureau, Pennsylvania State Chamber of Commerce, Harrisburg, Pennsylvania.

Frank D. Paine, professor of electrical engineering, Iowa State College, and assistant director, national Committee on the Relation of Electricity to Agriculture, Station A, Ames, Iowa.

Ernest W. Pilgrim, industrial department, General Electric Company, Schenectady, New York.

G. E. Simmons, professor of agronomy and head of department of agricultural engineering, University of Maine, Orono, Maine.

Raymond E. Storie, junior soil technologist, Northern Branch of the College of Agriculture, Davis, California.

Charles A. Utley, field engineer, The Pelton Water Wheel Company, 2908 F Street, Sacramento, California.

Hibbert M. Weathers, in charge of rural electric development, Alabama Power Company, Birmingham, Alabama.

Andrew Weiss, assistant director of reclamation economics, Bureau of Reclamation, Department of the Interior, Denver, Colorado.

TRANSFER OF GRADE

Wesley G. Nunn, instructor in agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. (From Student to Junior Member.)

Henry A. Wright, student trainee, J. I. Case Threshing Machine Company, Racine, Wisconsin.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the January issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Irvin H. Althouse, engineer Terra Bella Irrigation District and Vandalia Irrigation District, and consulting engineer for Irrigation Equipment Engineering Company, Terra Bella, California.

Herbert S. Hinrichs, field engineer, Engineering Experiment Station, Kansas State Agricultural College, Larned, Kansas.

J. H. Y. Kidd, district commercial manager, Central Hudson Gas & Electric Company, Poughkeepsie, New York.

Dr. George Kuehne, professor of agricultural engineering, University of the State of Bavaria, 39 Theresienstr., Muenchen (Munich), Germany.

Paul C. McGrew, junior drainage engineer, Division of Agricultural Engineering, University Farm, St. Paul, Minnesota.

Emory T. Miller, mechanical engineer, Manhattan Rubber Manufacturing Company, Passaic, New Jersey.

Wallace M. Murdock, in charge of tractor sales in Canada, Ford Motor Company of Canada, Ltd., 20 Gatwick Avenue, Toronto, Canada.

Phillip Schuyler, engineering editor, "Western Construction News," 24 California Street, San Francisco, California.

Charles C. Stedman, vice-president, works manager, and chief engineer, The Central Tractor Co., Greenwich, Ohio.

Frank J. Veihmeyer, associate irrigation engineer, College of Agriculture, Davis, California.

Norman T. Wilcox, sales development and rate studies, Stone & Webster, Inc., Boston, Massachusetts.

Carol W. Wright, superintendent Standford Vina Ranch Irrigation Co., Vina, Tehama County, California.

Necrology

E. B. McCORMICK

NEWS has just been received that Edmund B. McCormick, a past-president of the American Society of Agricultural Engineers, passed away at San Francisco, California, January 22, 1926, following an illness of but eleven hours. He was elected to membership in 1914 and served as president of the Society in 1914.

Mr. McCormick was born at Normal, Illinois, November 24, 1870. Upon graduation from the Illinois Normal University in 1888, he served a machinist apprenticeship in the Chicago & Alton Railroad Shops. He then attended Massachusetts Institute of Technology and graduated from that institution in 1897, with degree of bachelor of science in mechanical engineering. From 1898 to 1901 he was assistant professor of mechanical engineering at Montana State College and later professor of mechanical engineering. He later became dean of the division of engineering at Kansas State Agricultural College and resigned in 1906 to become associated with the Bureau of Public Roads of the U. S. Department of Agriculture, where he was put in charge of the testing work of the Bureau.

In 1915 he was made chief of what was then called the Division of Rural Engineering of the Bureau of Public Roads. In 1920 he was transferred to the supervision and distribution of surplus war materials which had been turned over by the government to the Department of Agriculture. In 1922 he went to San Francisco in connection with the same work and resigned from the Bureau on March 31, 1925, to go into a business of his own.

Employment Bulletin

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Nonmembers as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER, married, age 29, 1922 graduate of Iowa State College in agricultural engineering, now assistant engineer in construction department of International Railways of Central America, desires position where permanent residence is possible, preferably experimental or production work, or management of reclamation project or large ranch. Ten years experience in general farming with power equipment, experimental and teaching work, and construction work. Can speak Spanish, also some French and German. MA-130.

Positions Open

SALES ENGINEERS WANTED: One of the largest bearing manufacturers in America can use the services of two good sales engineers. Men with an engineering education and sales experience in farm tractor and implement field are preferred. They should have designing ability so that they can be of service to customers. Those experienced in the farm-implement and tractor design will be shown preference. Write fully giving all data as to experience, education and salary expected.

ENGINEER wanted, by one of the largest farm-machinery manufacturers, who is alive to the real engineering possibilities incidental to the manufacture of farm machinery, whose theoretical engineering training is complemented by a few years work at the drawing board in some engineering department and who will at once know the significance of routine efforts necessary to the accomplishment of any job in a production shop and be in position to appreciate the shop man's viewpoint. PO-111

AGRICULTURAL ENGINEER wanted for sales position in the East. Age 27 to 40. Must be in good health. In application state whether married or single, age, height, weight, religion, color of hair and eyes, also where employed for last three years and state experience, if any. Salary, expenses and commission. Address Louden Machinery Co., Albany, N. Y.